AGING OF CURE DATED ITEMS AND VARIOUS ELASTOMERIC COMPOUNDS

To: Oklahoma City Air Material Area

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INTRODUCTION

The following text represents a summary of the work performed on Project 1190-18 at the University of Oklahoma Research Institute under Contract AF 34(601)-5233PA for the Oklahoma City Air Materiel Area. The report is entitled: Aging of Cure Date Items and Various Elastomeric Compounds.

The report is divided into eleven separate sections. Each section describes a particular phase of the entire problem that was studied and evaluated. Conclusions have been made wherever possible.

SECTION I

Correlations Between Natural and Accelerated Aging and Mechanical Properties

An extensive literature search has been carried out in order to obtain information relative to the air aging of nitrile rubber. It was desired to obtain a correlation between degradation (aging) and a corresponding change in engineering properties. Results of testing programs indicate that tensile strength and modulus may increase, decrease, or remain essentially unchanged while ultimate elongation decreases during aging for all types of rubber. The elongation decrease seems to vary regularly with time, thus enabling extrapolation of high temperature tests to room temperature shelf aging in some cases.

Air Oven Method

Tests have been conducted to determine the best method of accelerated high temperature aging: the air oven, oxygen bomb, and air bomb were compared.[1] The air oven method gave more reproducible and uniform results than the oxygen and air bomb method. Work discussed in this report was performed by the air oven method.

Some difficulty arises in the air oven method because of the loosely defined operating conditions. One particular and very significant variable is air circulation. If correlation of data from different laboratories is desired the amount of air circulation must be controlled very precisely. A method that seems to improve the air oven technique is the test tube method, where samples are placed in a sealed test tube and inserted in the air oven.

Discussion

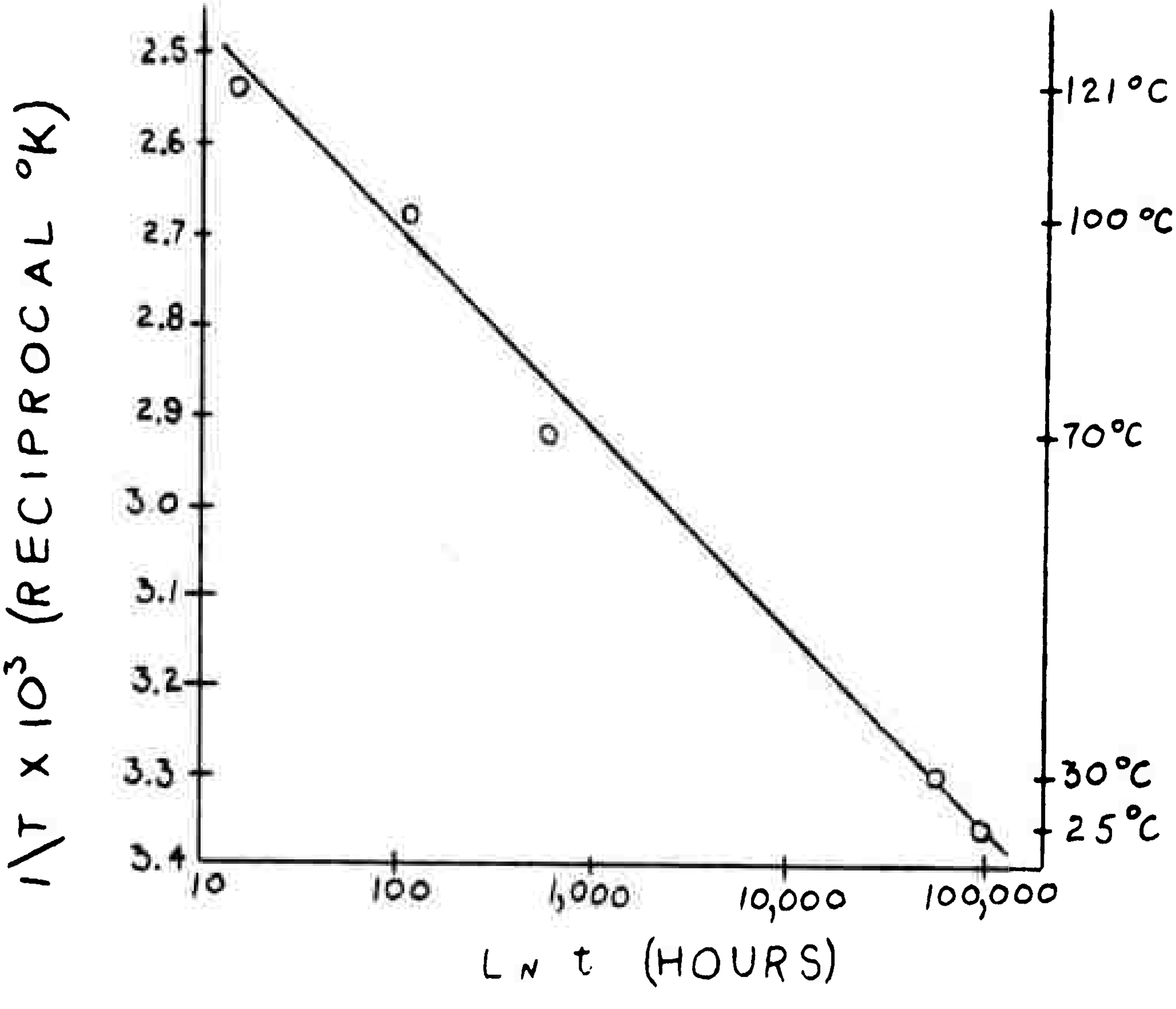
The physical changes in nitrile rubber vulcanizates that occur between 150°C and room temperature seem to be the same and have an

activation energy of 19,000± 2000 cal/mole; [2] therefore, extrapolation from high temperatures to room temperature should be permissible. But extrapolation is possible only if: 1) accelerated aging temperatures and service temperature are in the range of the same degradation mechanism, that is, degradation varies with time in a regular way; and, 2) the temperature dependence of the rate-limiting reaction for the specific rubber is known; that is, the actual rate that the physical properties vary with time-- some empirical equation to relate time with temperature.

Juve and Schoch have made extensive tests on aging of nitrile and other types of rubber [2,3,4]. In the first and second publications tests were reported at temperatures of 121°C, 100°C, 70°C, 25°C and an activation energy calculated. The data was somewhat incomplete and scattered but a linear correlation was shown when the reciprocal absolute temperature was plotted versus ln (time) at a constant loss of elongation. Hence, extrapolation to room temperature was possible. This is shown in Figure 1.

During the same period a 12 year testing program was being carried out in the United States (75°F) and in Liberia (85°F). Results of this test are shown in Table I and the data plotted in Figure 2.

FIGURE 1



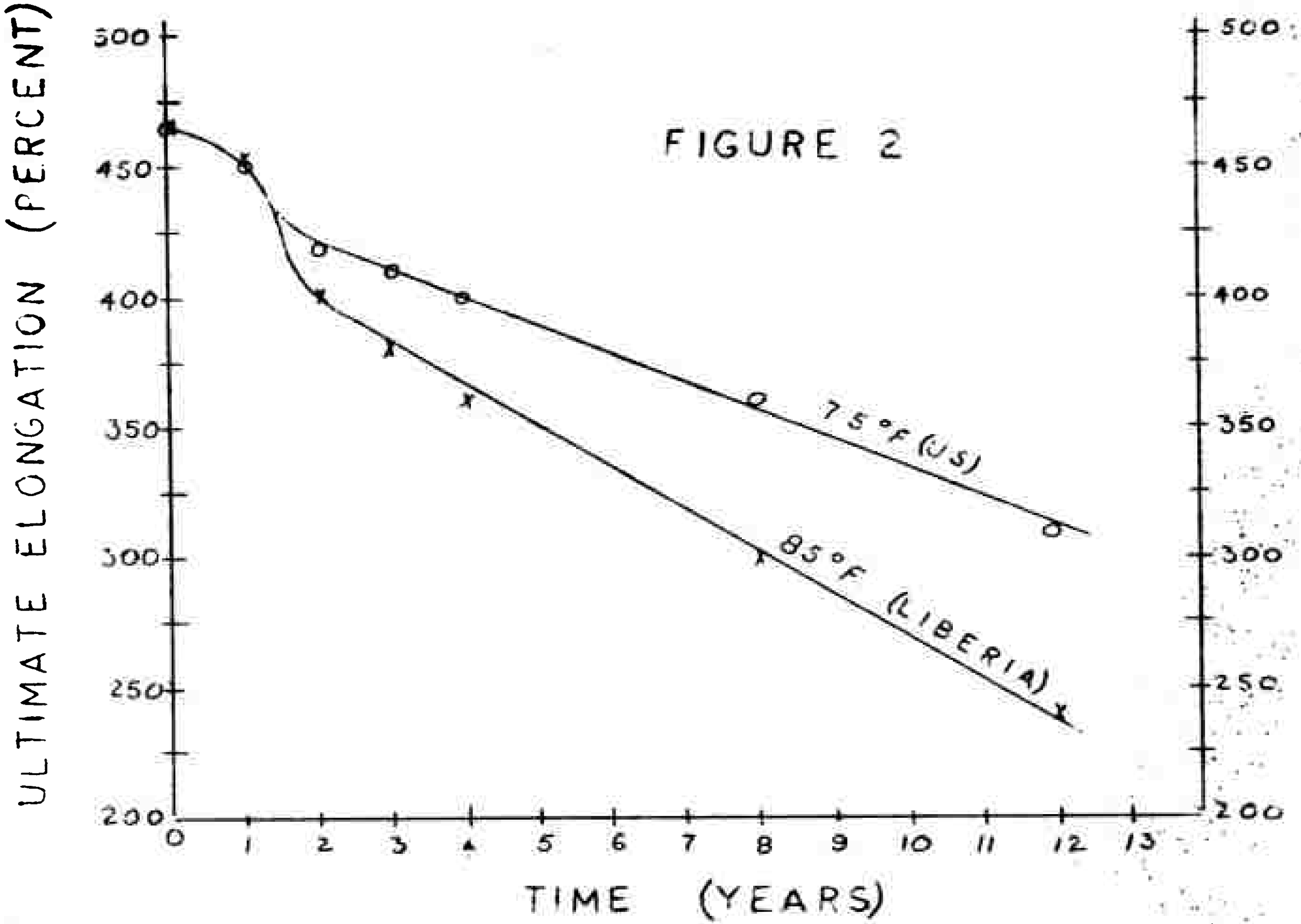
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
1/T X 10³ (RECIPROCAL °K)
121°C
100°C
70°C
30°C
25°C
10
100
1,000
10,000
100,000
Ln t (HOURS)

TABLE I

90' at 275°F Cure

Aging Time	300% Mod.	% Retained	Tensile Strength	% Retained	Elong.	% Retained
Original	1745	100	2500	100	465	100
1 year U.S.	1816	104	2487	99.5	450	96.7
2 years U.S.	1943	111.2	2450	98	417	89.6
3 years U.S.	1950	112	2540	101.6	410	88.1
4 years U.S.	2080	119.2	2580	103.1	400	86
8 years U.S.	2255	129	2545	102	362	77.8
12 years U.S.	2460	141	2700	108	310	66.6
1 year Liberia	2275	130.2	3210(?)	128.5	453	97.3
2 years Liberia	2100	120.2	2625	105	400	86
3 years Liberia	2200	126	2525	101	380	81.6
4 years Liberia	2400	137.5	2725	109	360	77.3
8 years Liberia	2625	150.5	2625	105	300	64.4
12 years Liberia	-	-	2575	103	240	51.6

FIGURE 2



ULTIMATE ELONGATION (PERCENT)
500
450
400
350
300
250
200
0
1
2
3
4
5
6
7
8
9
10
11
12
13
TIME (YEARS)
75°F (US)
85°F (LIBERIA)

Linear correlation is possible and yields a 33.4% decrease in elongation in 12 years. This decrease in elongation is permissible in most applications.

Mandel et al. [5] of the National Bureau of Standards made room temperature and high temperature tests independently and also used the data from the test previously mentioned and attempted to extrapolate to room temperature. It is important to note that different recipes were used.

TABLE II

Juve and Schoch [2]

Hycar OR-15	100 parts
Zinc Oxide	5
Stearic Acid	1
Sulfur	1.5
Benzothiazyldisulfide	1.5
SRF Black	75
Plasticizer SC	15
TKP	15

Mandel et al. [5]

Nitrile Rubber	100 parts
Zinc Oxide	5
Stearic Acid	1.0
Sulfur	1.5
Benzothiazyldisulfide	(?)
Gas Furnace Black	40

Mandel found that the equation $E = E_o - kt^{\frac{1}{2}}$ satisfactorily represented the behavior of nitrile rubber. E is the elongation after aging, E_o and k are constants for a specific type rubber, and t the time in days. The change in elongation, $E - E^*$, is plotted with respect to $t^{\frac{1}{2}}$ at each test temperature (E^* is the initial elongation). The

value of k and E_o are read off the plot as the slope and ordinate intercept respectively. Results of Mandel's study of accelerated aging are shown in Figure 3. Correlation of data from Juve and Schoch by the equation proposed by Mandel is shown in Figure 4.

Values of k were determined at the measured temperatures and are listed in Table III.

TABLE III

Juve and Schoch

Temp °C	k
25	2.76
70	47
100	75
121	154

Mandel

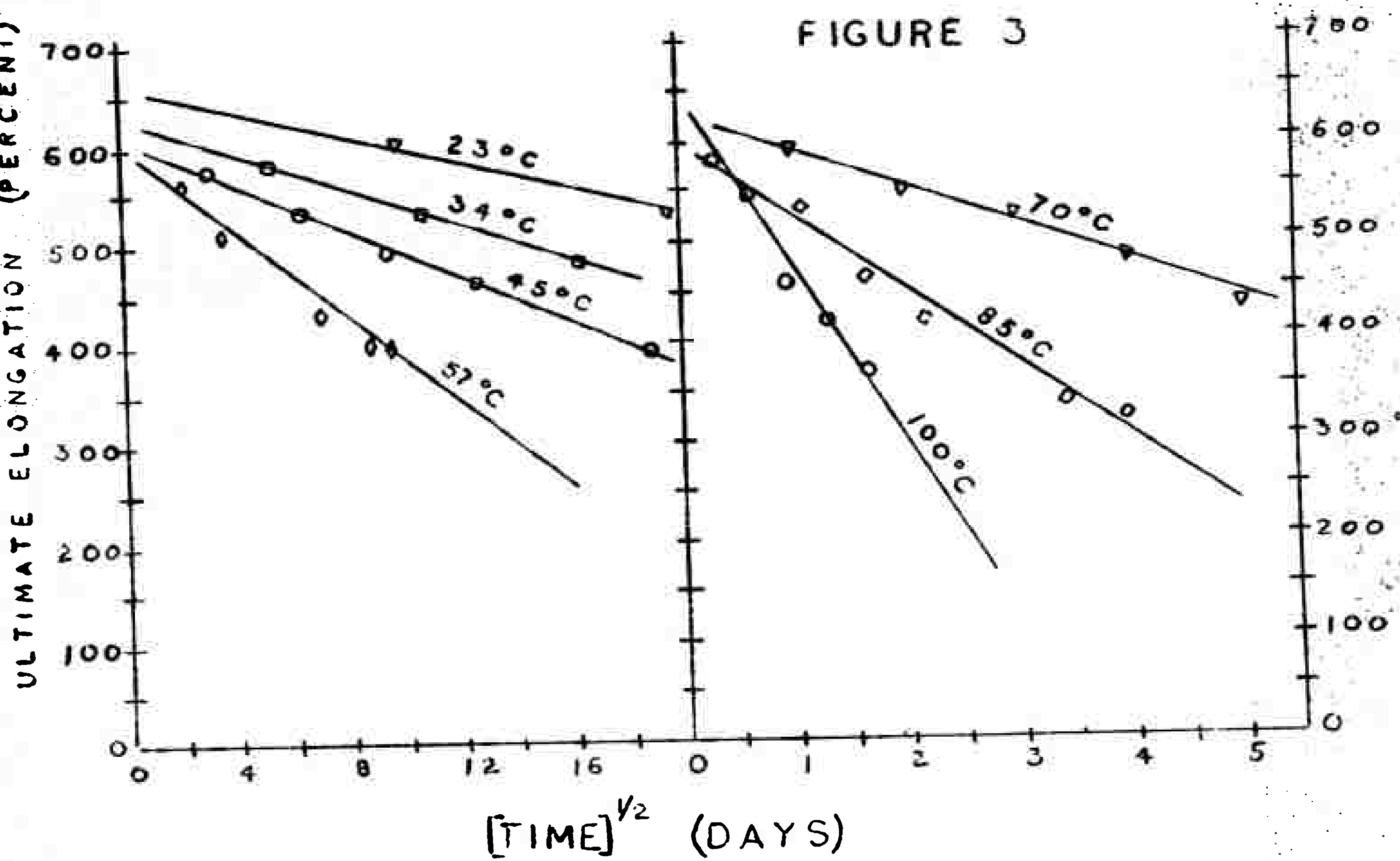
Temp °C	k
23	6.4
34	8.9
45	11.4
57	21.1
70	33.6
85	74.2
100	180.4

An attempt was made to correlate ln k with reciprocal temperature in hopes that a linear correlation may be obtained. Figure 5 shows this correlation. The non-linear plot from Mandel's work is in direct disagreement with the work of Juve and Schoch and says effectively that room temperature aging can not be predicted from high temperature results only. Mandel reports that by using the above method the aging time for most rubber compounds may be predicted up to 10 years, but that the values of k and E_o must be experimentally determined for each type rubber.

Analysis

Only two sources of data on nitrile rubber aging were found in the literature, and the two sets of data do not agree. Mandel's analysis

FIGURE 3



ULTIMATE ELONGATION (PERCENT)
700
600
500
400
300
200
100
0
23°C
34°C
45°C
57°C
70°C
85°C
100°C
0
4
8
12
16
0
1
2
3
4
5
[TIME]^1/2 (DAYS)

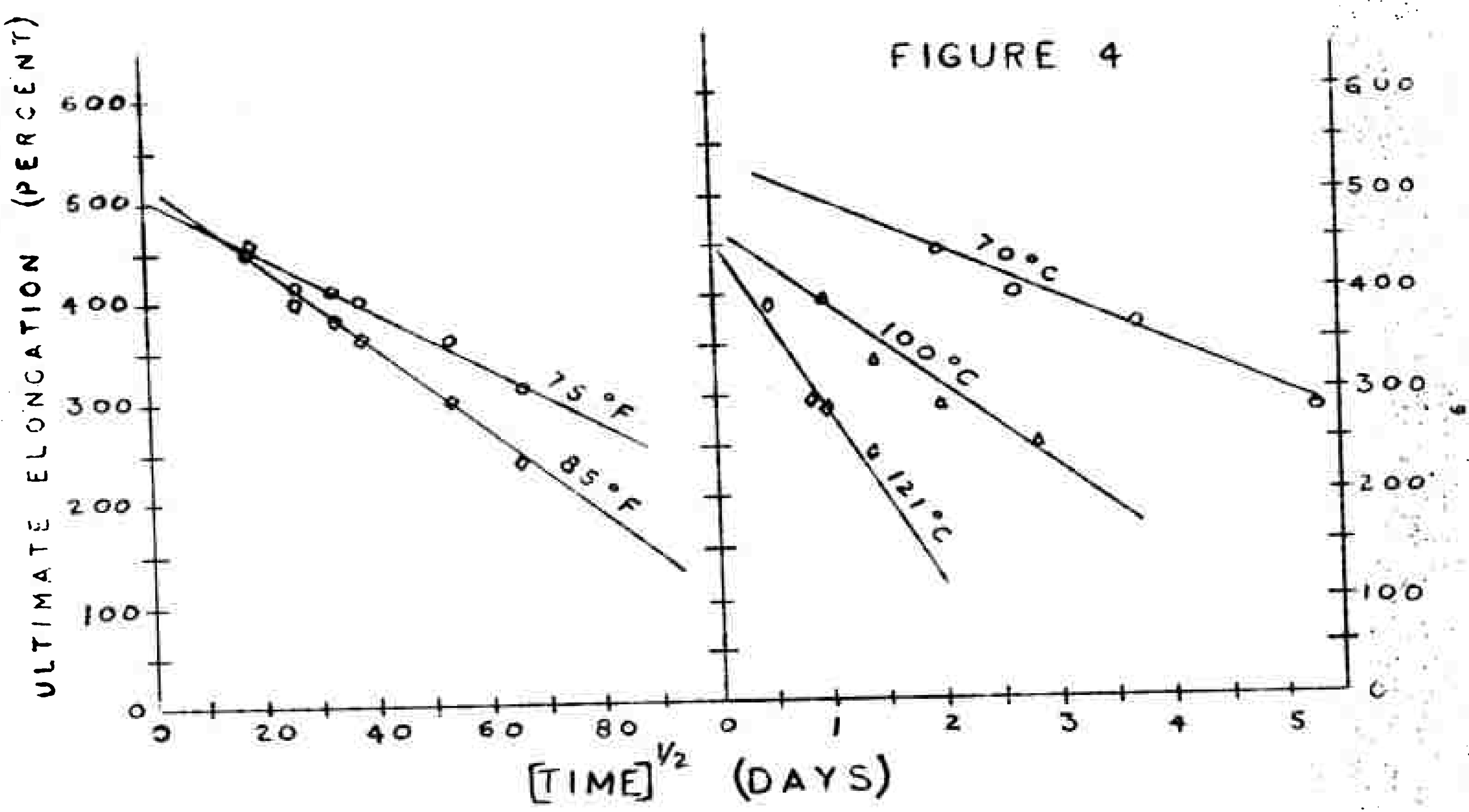
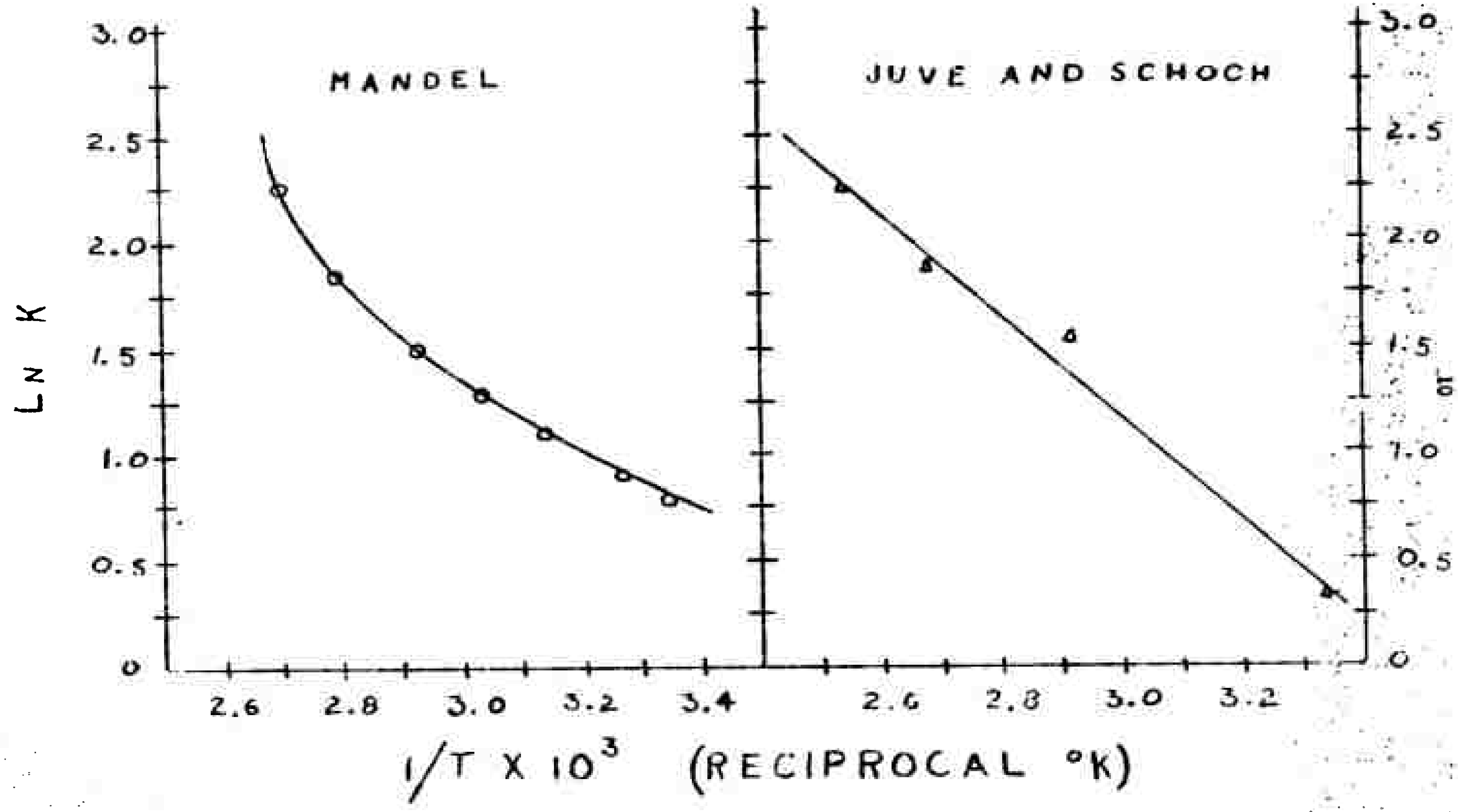


FIGURE 4
ULTIMATE ELONGATION (PERCENT)
600
500
400
300
200
100
0
20
40
60
80
1
2
3
4
5
75 °F
85 °F
70 °C
100 °C
121 °C
[TIME]^1/2 (DAYS)

FIGURE 5

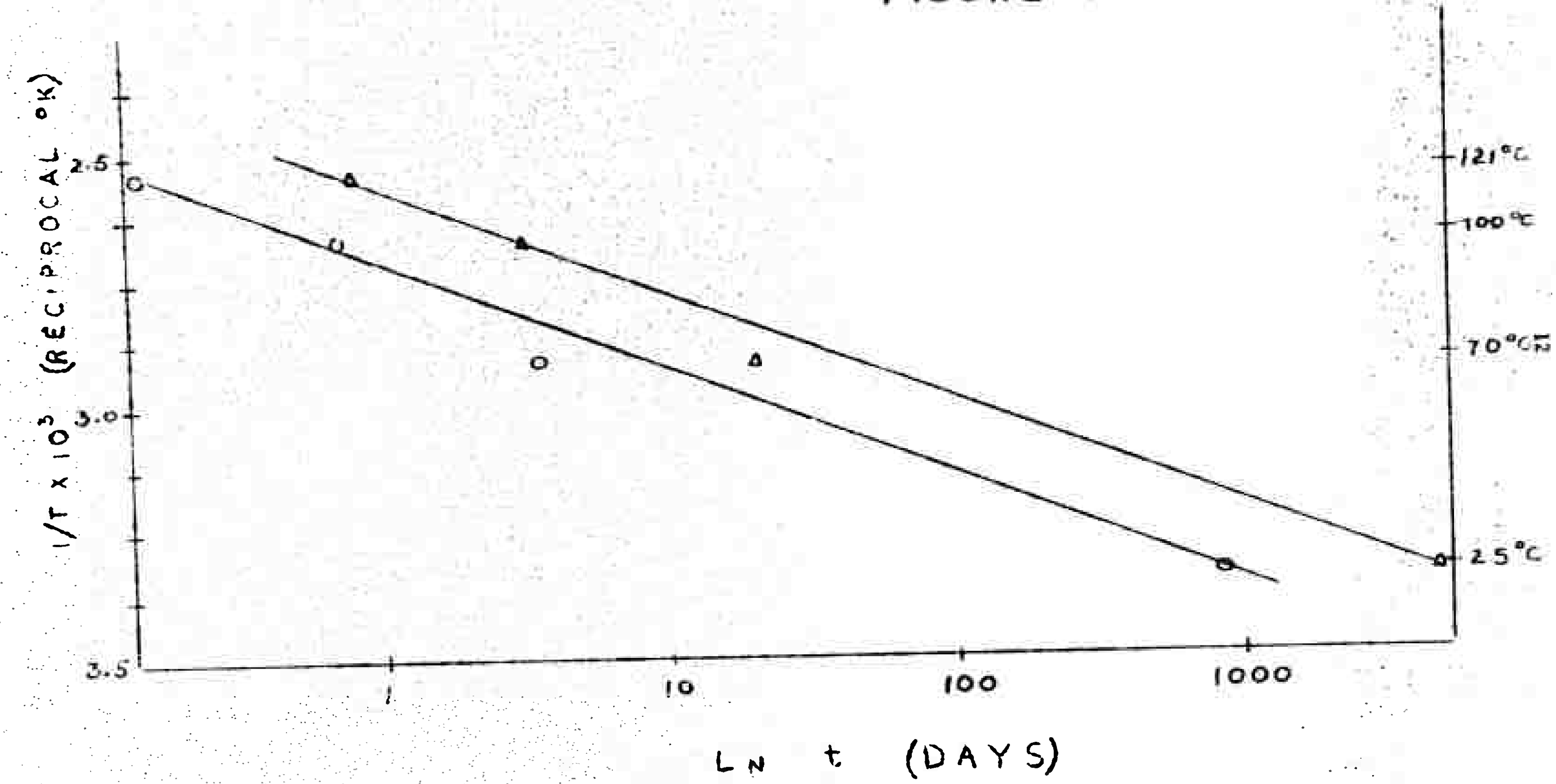

MANDEL
JUVE AND SCHOCH
LN K
3.0
2.5
2.0
1.5
1.0
0.5
0
2.6
2.8
3.0
3.2
3.4
1/T X 10³ (RECIPROCAL °K)

of the non-linear variation of k with 1/T seems to be consistent and represents a more sound approach than that of Juve and Schoch.

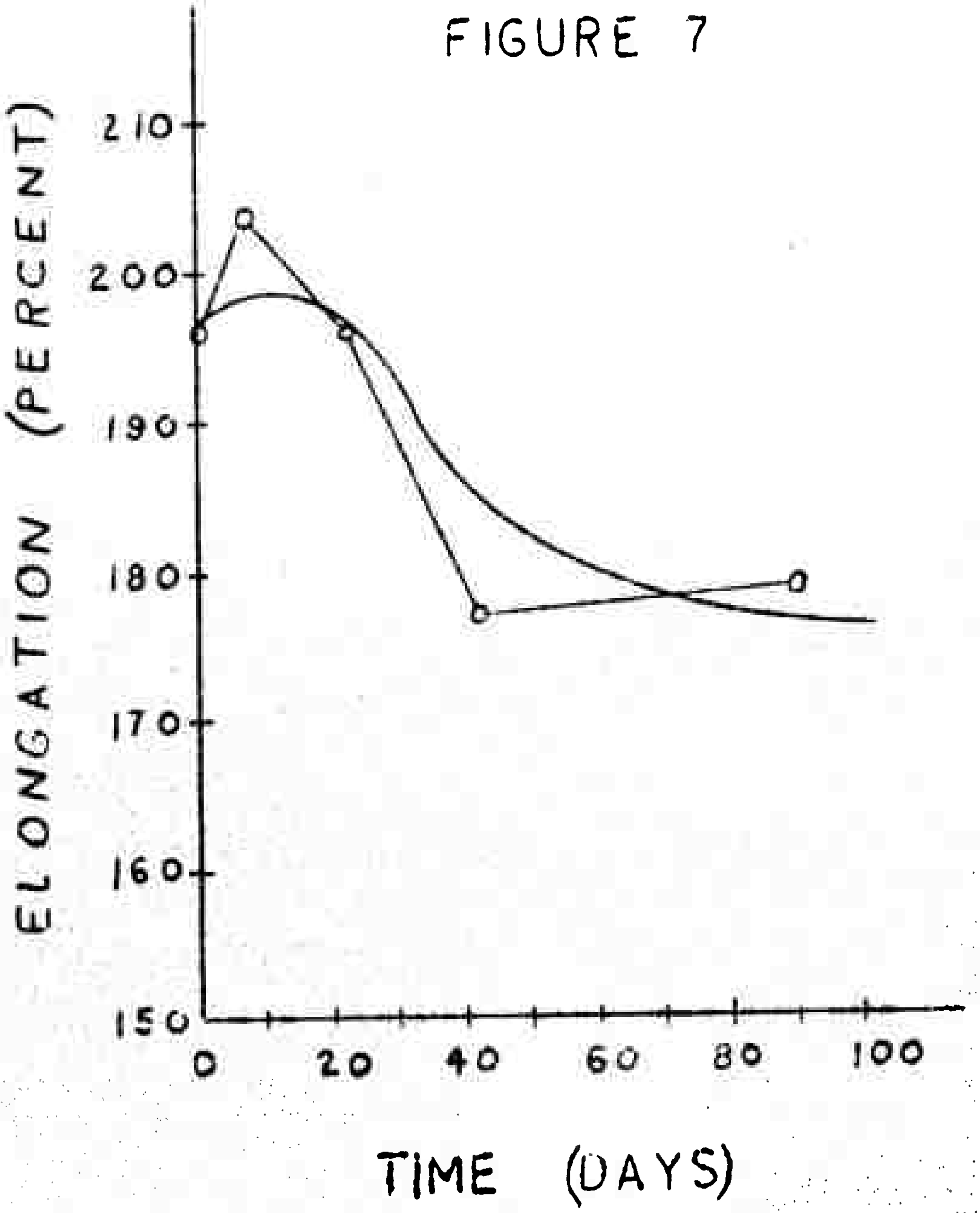
Figure 6 shows the analysis of data with the equation, $E = E_0 - kt^{\frac{1}{2}}$. The triangle points represent calculated data with an elongation decrease of 33.4% and the circles a decrease of 14%. The values for elongation decrease are taken from the 12 year in situ test discussed earlier. Points on the figure were plotted from calculations utilizing determined k-values and a 33.4 and 14% elongation decrease at a particular temperature. Because of the limited extent of data available it was possible to draw several lines through the data points. The data at 25°C was calculated from short time tests and extrapolated. A line through the four calculated points comes fairly close to the measured values (the 70°C point seems bad in both cases), but using only the high temperature point results in gross error. A predicted value for 14% decrease in elongation is 2.4 years (4 years actual) and for a 33.4% decrease--- 13.5 years (12 years actual).

It is of interest to note that elongation is not a linear function in the early stages of deterioration (Figure 2). A similar trend was observed in preliminary tests made at OCAMA. The tests were discontinued after 91 days but the non-linear portion of the curve is evident and the correlation is shown in Figure 7.

FIGURE 6



1/T x 10³ (RECIPROCAL °K)
2.5
3.0
3.5
121°C
100°C
70°C
25°C
1
10
100
1000
LN t (DAYS)



OCAMA TESTS AT 70°C

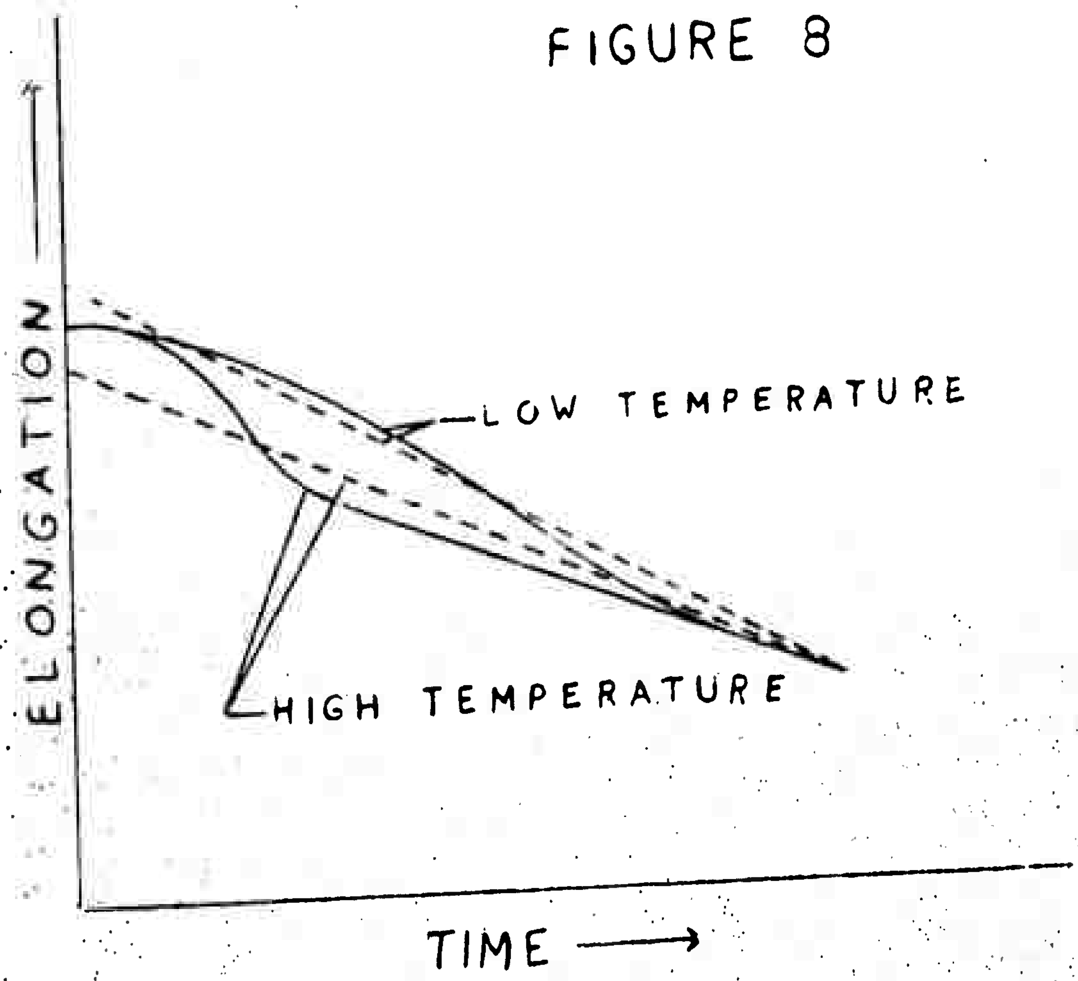
TABLE IV

	Temp. (°C)	E^* (Percent)	E_o (Percent)	$E_o - E^*$ (Percent)
Mandel, et al.	23	652	657	+ 5
	34	623	626	+ 3
	45	609	608	- 1
	57	614	603	-11
	70	596	613	+17
	85	609	600	- 9
	100	656 <654>	647	- 8
Juve and Schoch	25	465	500	+35
	70	465	532	+67
	100	465	468	+ 3
	121	465	450	-15

In Table IV values are given for E^* (initial elongation) and E_o at different temperatures from two different experiments [2,5]. As can be seen the value of $E_o - E^*$ goes from positive at low temperatures to negative at high temperatures. The relative time duration of the after-vulcanization effect is probably much shorter at high temperature than at low temperature. Then, if two samples of the same rubber were aged at different temperatures for a short time, the after-vulcanization effect could still be present in the low temperature aging whereas it would have been completed in the high temperature test.

In Figure 8 an attempt has been made to graphically explain the variation of E_o with E^*. Percent elongation is plotted schematically at two temperatures as a function of time on different time scales for a given loss of elongation. Straight lines are fitted to the data. Note that the low temperature data will give an extrapolated value of E_o at

FIGURE 8



time zero that is greater than E^*. At higher temperatures the extrapolated value of E_o is lower than E^*. Thus the value of E_o and k are functions of the after-vulcanization effect as well as temperature and composition.

Future Work

In all the experimental accelerated aging tests the first determination gave a substantial loss in elongation. It is proposed to make tests at high temperatures, in order to measure significant changes in elongation in short intervals of time. For example, at 100°C determine the elongation every 3 - 4 hours and at 125°C at intervals of 1 - 2 hours.

The change in cross-linking in the samples would be checked by swelling tests to determine how the cross-linking changed with the after-vulcanization effect. The amount of free sulfur could be checked at each interval to determine how much of the free sulfur has reacted. Infrared absorption spectra (7) would possibly indicate changes in chemical groups present and molecular rearrangements.

If the after-vulcanization effect could be understood and compensated, extrapolation of high temperature accelerated aging data to shelf aging temperatures would be more reliable than at the present time.

SECTION II

Vapor Phase Swelling

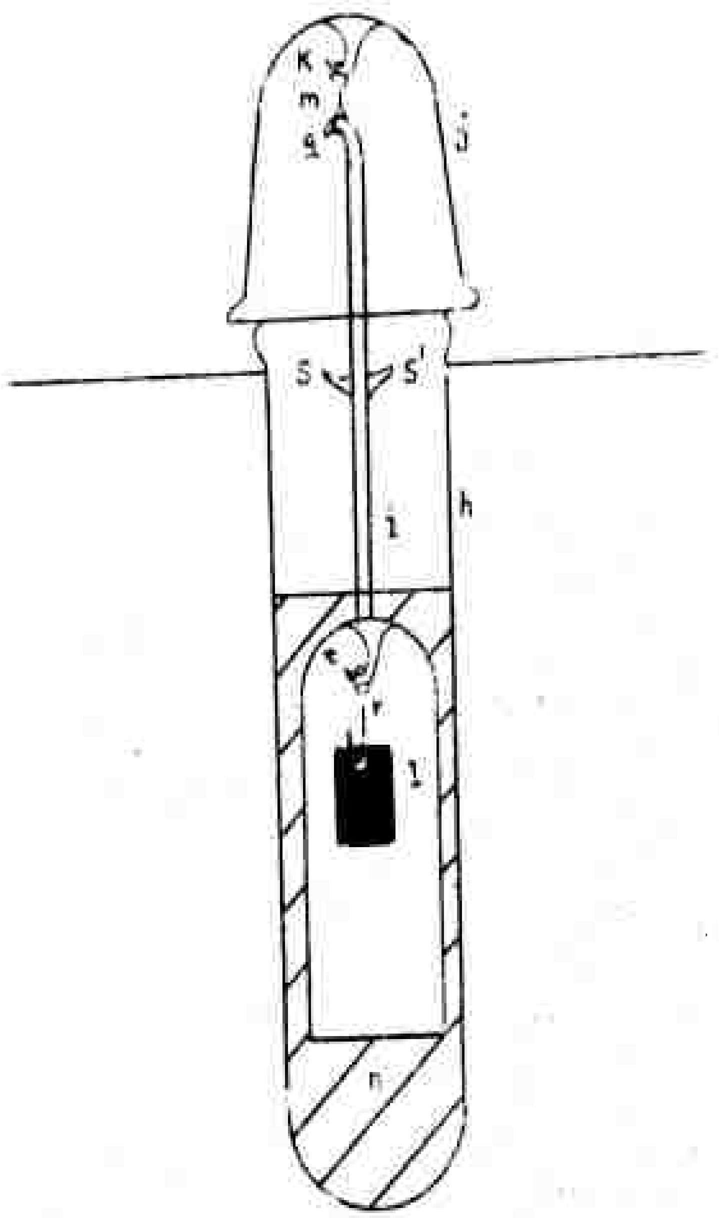
Introduction

In order to study the swelling of elastomers in organic solvents a new technique was devised that would allow determination of the extent of swelling as a function of varying solvent activity or partial pressure. The advantage of this technique over the more common techniques is that swelling measurements can be made without the necessity of immersing the sample in the swelling liquid. This not only eliminates leaching of soluble materials from the rubber but permits swelling studies at any desired solvent vapor pressure instead of only the saturation vapor pressure to which the immersion techniques are limited.

Apparatus

The modified test tube apparatus devised for this technique is shown in Figure 9. Tube h is an 8 inch test tube fitted with a 24/40 $\mathsf{\$}$ cap j, which has a small glass hook, k, sealed to the inside of the top. A glass insert i is suspended from the hook, k, by means of a wire, m, and hook q. The lower portion of the insert has a hook, t, sealed to the inside and is completely surrounded by the swelling fluid, n. The rubber sample, l, is suspended from hook t by means of a wire, r, about one cm. or so below hook t. When the insert is lowered into the swelling fluid trapped air prevents the fluid from rising into the portion of the insert containing the rubber sample. To prevent the insert from floating in the fluid lead collars were placed around the stem of the insert. Hooks s and s' prevent the collar from slipping to the lower portion of the stem and can also be used to suspend additional weights if necessary. The entire tube is wrapped in aluminum foil to

FIGURE 9



MODIFIED TEST TUBE
SWELLING APPARATUS

aid in maintaining constant temperature and the tube is immersed in constant temperature bath P, so that the surface of the swelling liquid is several inches below the water surface. Several samples are run simultaneously by supporting six such tubes in the same constant temperature bath.

The swelling fluids used consisted of mixtures of hexadecane and benzene for which total vapor pressure had been determined as a function of the concentration. Approximately 30 mls. of varying concentrations of this mixture was placed in each tube.

Procedure

In making a run, weighed samples were suspended in the apparatus and the constant temperature bath was adjusted to the required temperature. After equilibrating for several days, each sample was taken from the apparatus, quickly transferred into a pre-weighed weighing bottle, and weighed. The concentration of benzene in the swelling fluid was determined by a refractometer measurement. It was discovered that samples reached a nearly constant weight within 2 or 3 days; hence, as a standard procedure, each specimen was left in the apparatus for three days.

Preliminary Results

Swelling isotherms were determined for specimens of a Buna-N type rubber. The samples used in the modified test tube method measured approximately 1 cm X 2 cm X 3 mm, and weighed between 0.5 and 1.0 gram.

Results of measurements on the Buna-N samples in benzene are given in Figures 10 and 11, where isotherms at 10°, 20°, and 30°C are shown.

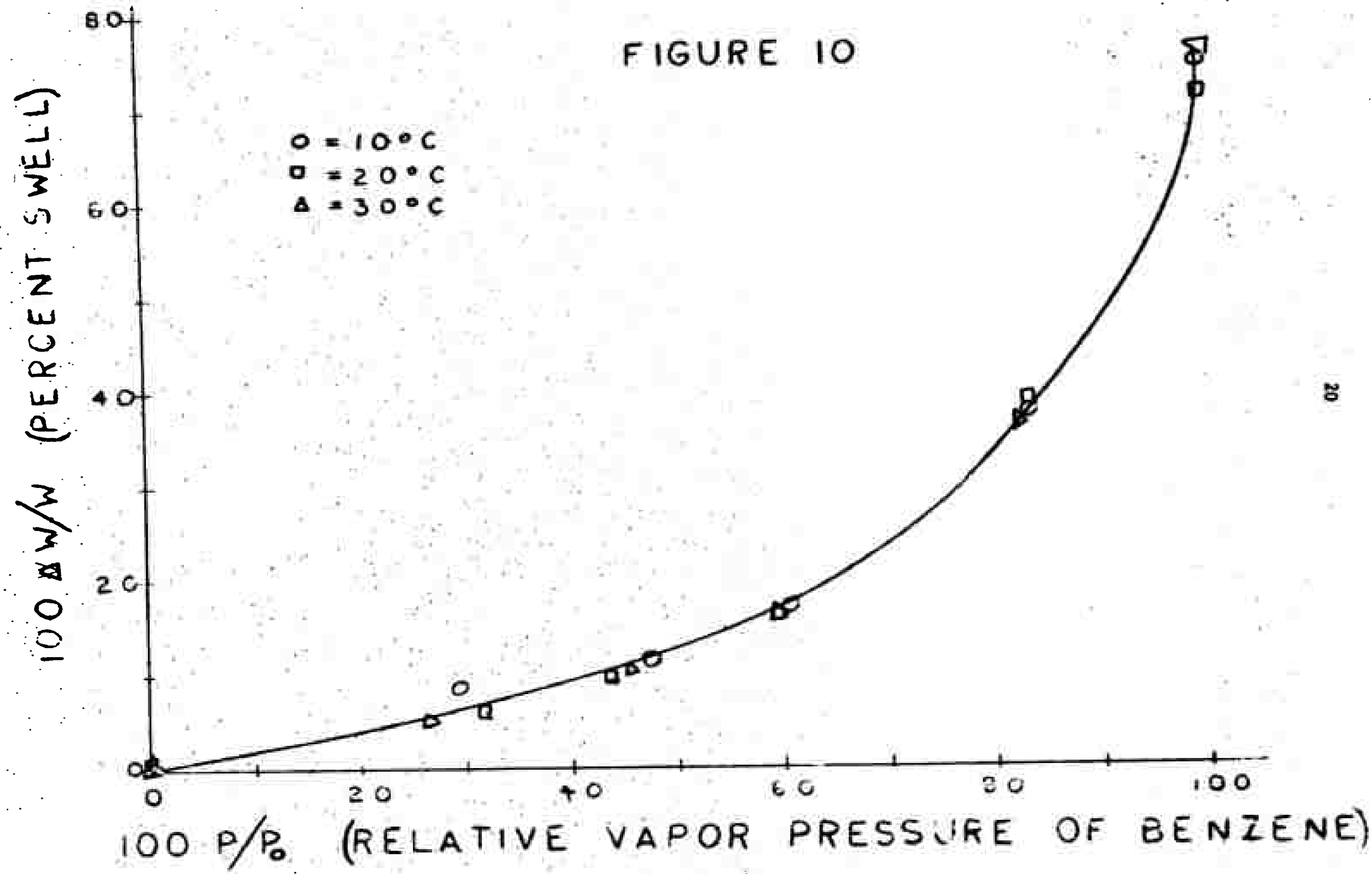

O = 10°C
□ = 20°C
Δ = 30°C
80
60
40
20
0
20
40
60
80
100
100 ΔW/W (PERCENT SWELL)
100 P/P₀ (RELATIVE VAPOR PRESSURE OF BENZENE)

FIGURE 10

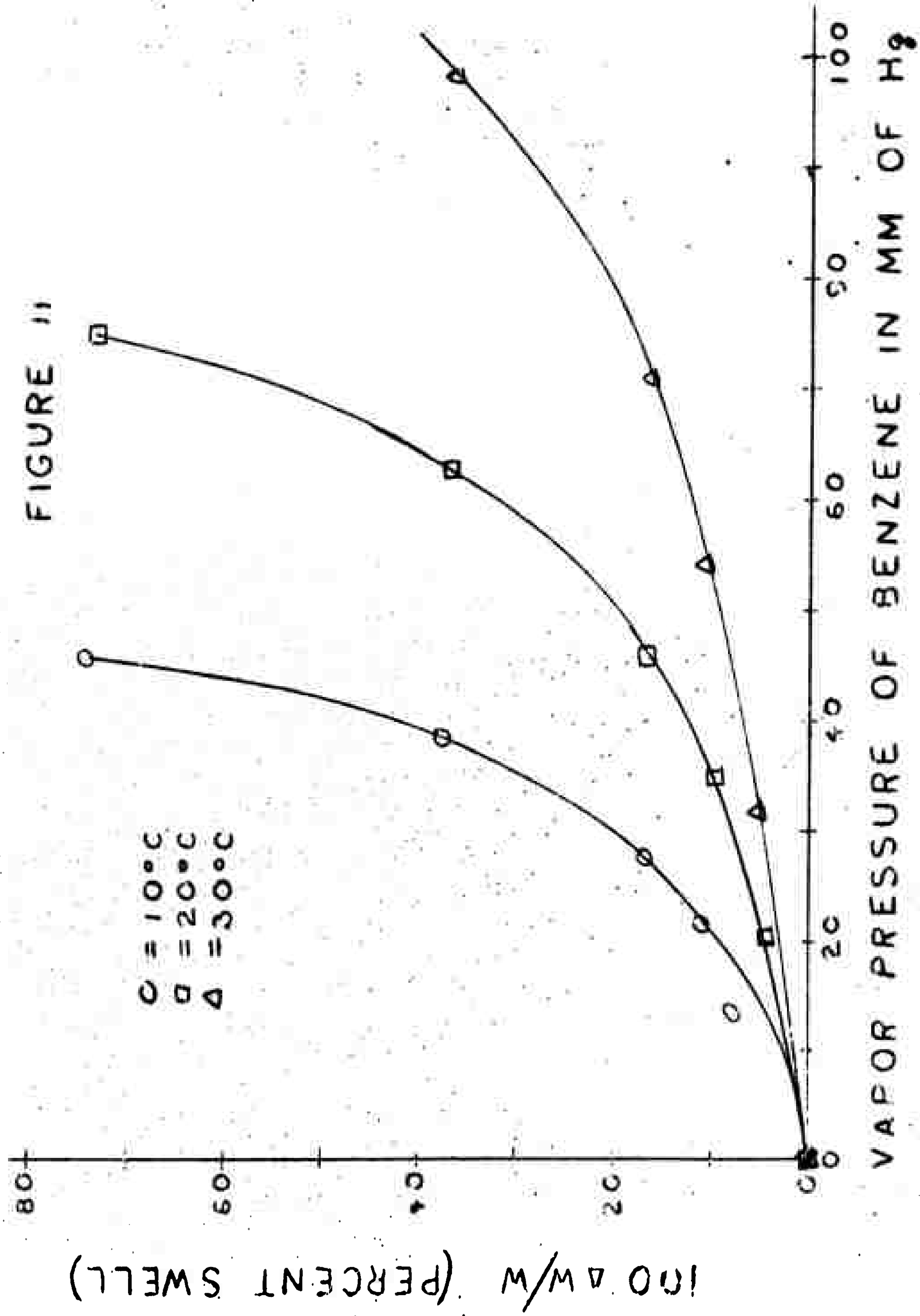

O = 10°C
□ = 20°C
△ = 30°C
VAPOR PRESSURE OF BENZENE IN MM OF Hg
100 Δw/w (PERCENT SWELL)
0
20
40
60
80
100

FIGURE 11

In Figure 10 percent weight increase, $(\Delta W/W)100$, is plotted versus percent of saturation vapor pressure, $(P/P_0)100$. In Figure 11 percent weight increase, $(\Delta W/W)100$, is plotted versus vapor pressure of benzene.

In order to illustrate the advantage of the test tube swelling method over the immersion techniques, six rubber samples of the type used in the swelling determinations were immersed in benzene which was contained in an enclosed tube to prevent evaporation and allowed to swell from 2 to 118 hours. At a prearranged time the sample was removed from the solvent and evacuated under reduced pressure in a vacuum desiccator until a constant residue weight was obtained. The weight percent of the sample dissolved by the solvent was calculated by dividing the residue weight by the original sample weight. At the same time another sample was suspended above pure benzene for 120 hours. The benzene vapors were absorbed by the sample until the sample had become saturated, at which time the vapors condensed on the surface of the sample and dripped back into the liquid solvent producing a slight leaching effect.

In the tubes containing the immersed samples the sample became saturated with solvent within the first ten hours (The time required for saturation had been determined in a previous experiment). Leaching of the sample occurred rapidly during this time and appeared to become non-existant after the sample became saturated. However, more than five percent of the sample had been dissolved at the end of two hours and more than ten percent had been dissolved at the end of 22 hours. On the other hand the sample suspended above the solvent became saturated with solvent within 72 hours but at the end of 120 hours had lost less

than one percent of its weight due to dissolution. Results of this experiment are summarized in Table V.

TABLE V

Initial Sample Weight (grams)	Weight of Sample Dissolved (grams)	Type of Solvent Exposure	Time of Solvent Exposure (hours)	Percent of Sample Dissolved
0.8350	0.0425	Immersion	2.0	5.09
0.8129	0.0729	Immersion	7.5	8.97
0.8047	0.0857	Immersion	22.5	10.65
0.8456	0.0827	Immersion	46.5	9.78
0.7983	0.0809	Immersion	67.0	10.13
0.8713	0.0872	Immersion	118.0	10.01
0.7520	0.0062	Suspension	120.0	0.82

Vapor Swelling Studies

Vapor swelling studies were conducted on two Buna-N type rubbers (MM-81848-R from Continental Rubber Works and SR-822-60 from Stillman Rubber Company) and one silicone rubber to determine if there was a correlation between the degree of loss of useful properties of the rubber and its swelling behavior.

The first phase of this study involved the determination of the change in the swelling ability of a rubber sample with prolonged exposure to moderately high temperatures. The rubber samples were heated in a drying oven for the desired length of time, removed from the oven and allowed to cool to room temperature overnight. The samples were then weighed, swelled in the modified test tube apparatus for six days at 20°C and approximately 65.6 mm of benzene vapor pressure (normal vapor pressure of benzene at 20°C is 75.1 mm.), and reweighed to determine the amount of vapor absorbed by the rubber.

The results of one study using all three types of rubber are given in Figure 12, where the percentage change in sample weight due to swelling $\left[(\Delta W/W)100\right]$ is plotted versus aging time in days. The samples were heated in air at 70°C.

The curves for all three types of rubber show a fairly rapid decrease in swelling ability during the first two weeks followed by a linear decrease for longer periods.

Of the two Buna-N rubbers the SR-822-60 exhibits the greatest stability against aging, while the silicone rubber is the most stable of the three. However, the curves for the two Buna-N rubbers have negative slopes in the linear portions of the curves whereas the linear portion of the curve for the silicone rubber seems to show a very slight positive slope, indicating that its swelling ability improves with aging time. This would in turn indicate a softening of the rubber due to chemical changes occurring in the rubber or to breaking of cross-links in the rubber.

In order to determine the dependence of swelling ability of rubber samples with aging temperature, SR-822-60 rubber samples were heated in air at 70°C and 50°C. After aging for a specified time the samples were removed from the ovens and swelled in the manner described above. Figures 13 and 14 show the results of these tests. Figure 13 is the curve for samples aged at 70°C and Figure 14 is the curve for samples aged at 50°C.

Examination of the curves shows that the rapid decrease in swelling ability during the first two weeks is absent. However, comparison

FIGURE 12

70°C AGING

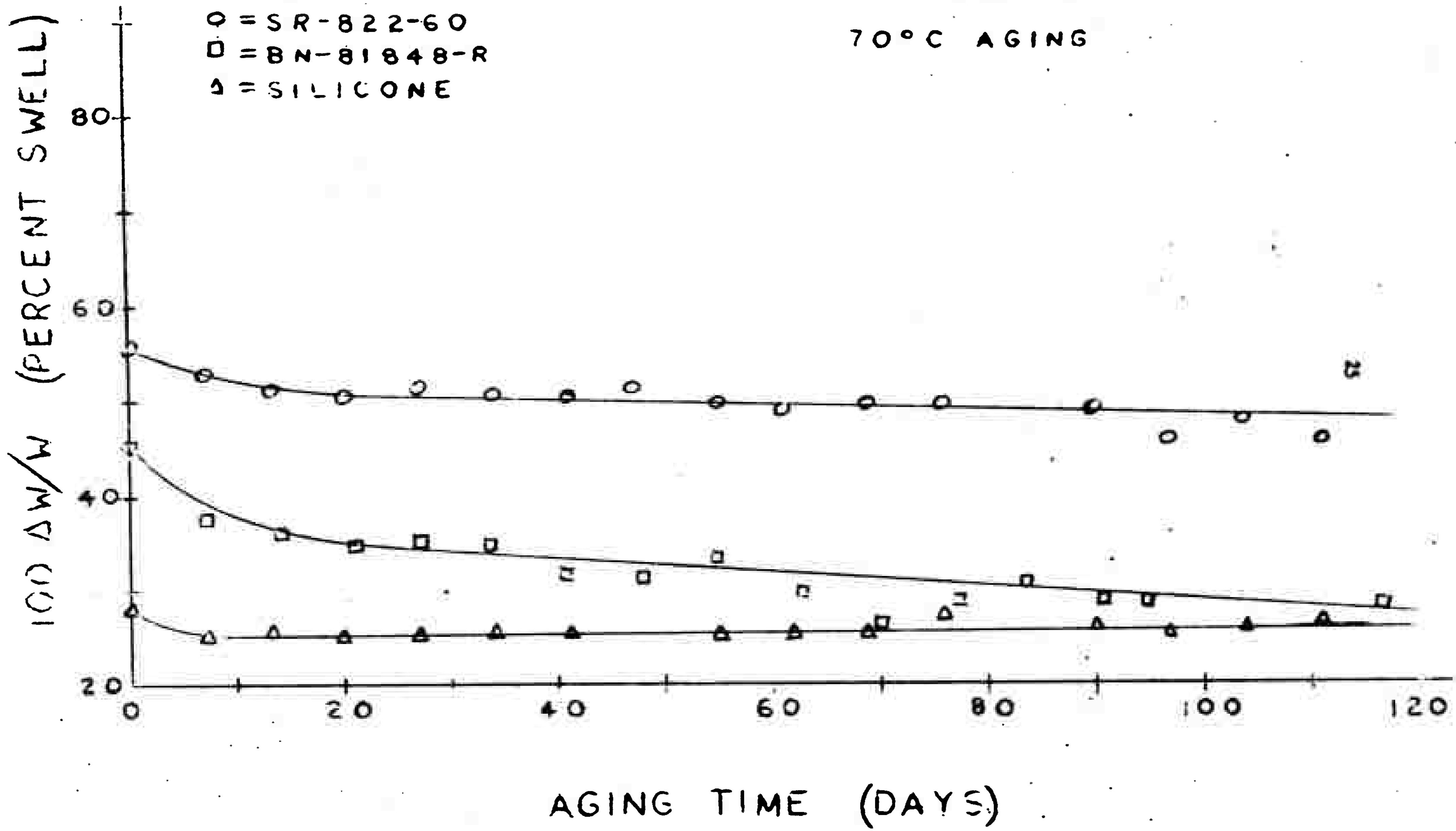


FIGURE 13

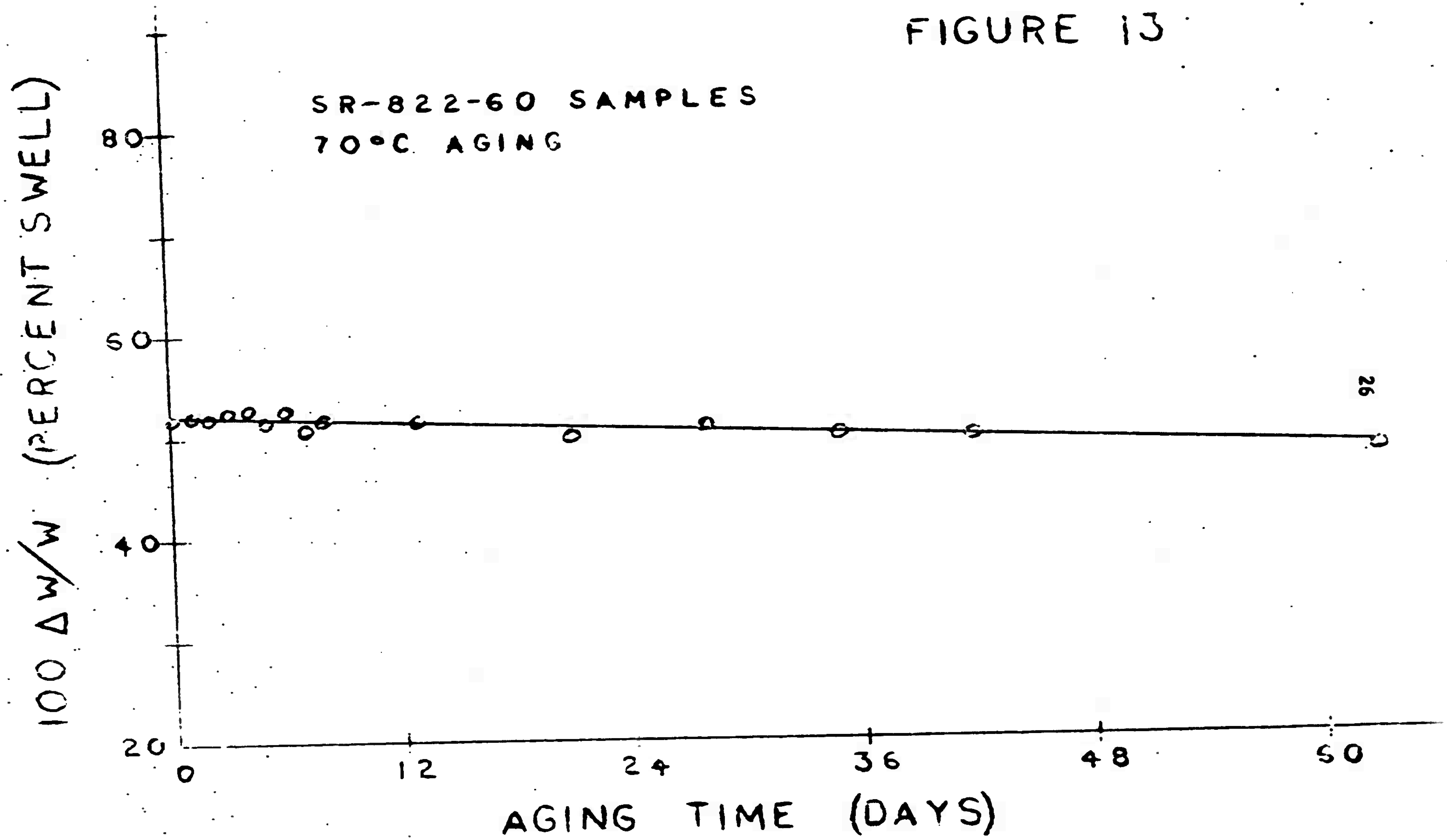
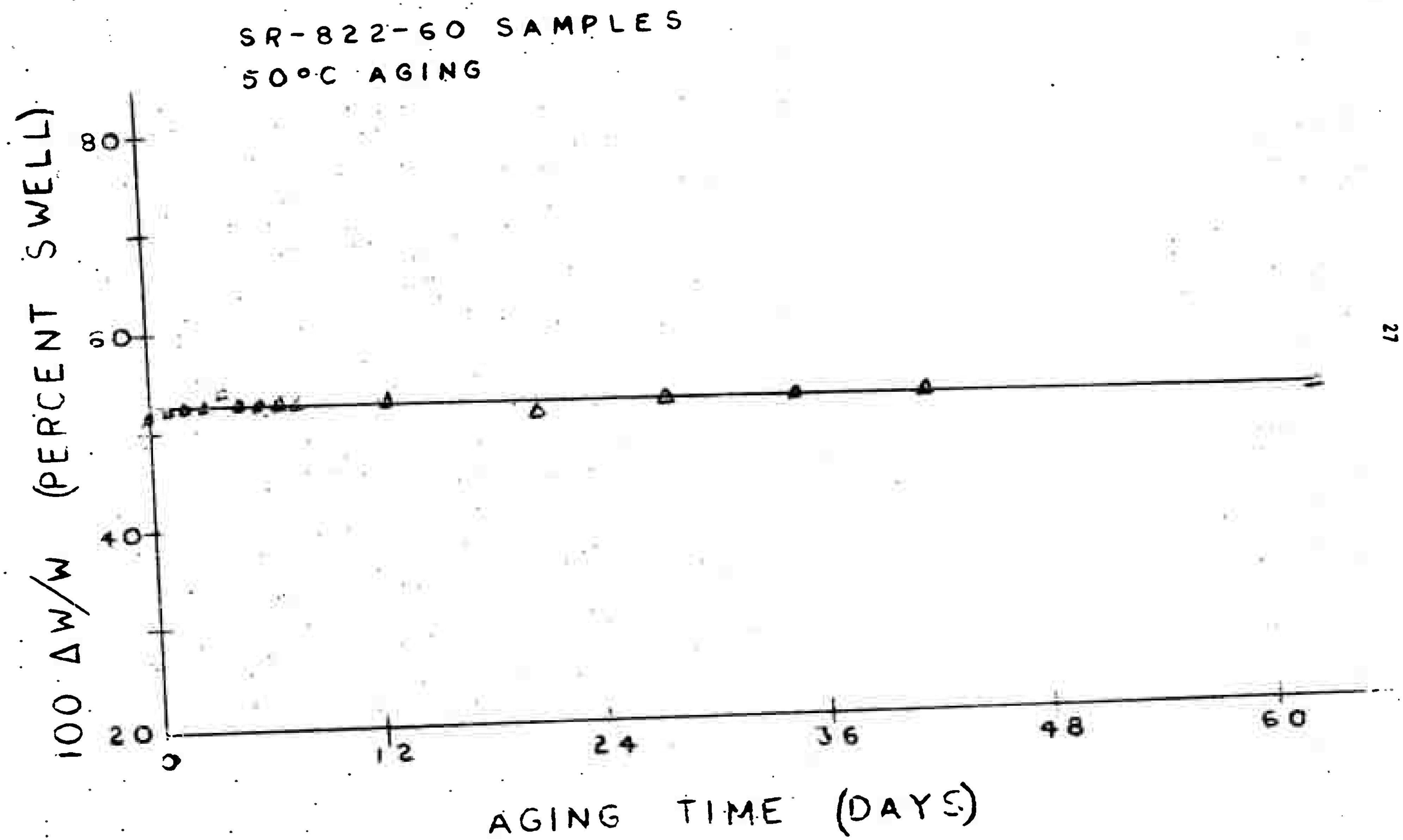

SR-822-60 SAMPLES
70°C AGING
100 ΔW/W (PERCENT SWELL)
80
60
40
20
0
12
24
36
48
60
AGING TIME (DAYS)

FIGURE 14


SR-822-60 SAMPLES
50°C AGING
100 ΔW/W (PERCENT SWELL)
80
60
40
20
0
12
24
36
48
60
AGING TIME (DAYS)

of the linear portion of the SR-822-60 curve in Figure 12 with the curve in Figure 13 shows that both curves have the same slope. The only difference between the curves in Figures 13 and 14 is the more gradual slope in Figure 14. This is to be expected since the rubber should age at a slower rate when the aging temperature is decreased.

If one neglects the first portion of the curves in Figure 12 and considers only the linear portion, the curves in Figures 12, 13, and 14 can all be expressed by the mathematical formula for a straight line,

$$y = mx_D + b \tag{1}$$

where $\underline{m}$ is the slope, $\underline{b}$ is the y-intercept, $\underline{x_D}$ is the aging time in days and $\underline{y}$ is the percentage weight increase due to swelling.

Since the slope of the curve depends on the aging temperature the slope, $\underline{m}$, becomes the aging factor.

Solving equation (1) for $\underline{m}$ gives:

$$m = \frac{y - b}{x_D}, \tag{2}$$

which can also be written,

$$m = \frac{\left[(\Delta W/W - (\Delta W/W)_0\right] 100}{t_D} \tag{3}$$

where $(\Delta W/W)_0$ is the percentage weight increase at zero aging time and t_D is the aging time in days. Because $(\Delta W/W)_0$ is usually larger than $(\Delta W/W)$ the curve will generally have a negative slope.

For a given rubber sample the slope, $\underline{m}$, is dependent on the aging temperature and the aging stability of the rubber which should be a constant for each type of rubber. Therefore, it can be assumed that $\underline{m}$

consists of two factors; the aging temperature factor $\underline{T}$, and a constant, $\underline{a}$, which we shall call the stability constant of the rubber. The temperature factor, $\underline{T}$, is used instead of the temperature because the temperature functional relationship is not known.

Equation (3) can then be written,

$$aT = \frac{\left[(\Delta W/W) - (\Delta W/W)_0\right] 100}{t_D} \qquad (4)$$

Once $\underline{a}$ and $\underline{T}$ have been determined for one type of rubber the swelling ability of this rubber at any aging temperature and time can be determined simply by determining $(\Delta W/W)_0$.

It is possible that the rubber may become so brittle if the aging is continued for a sufficiently long enough time that it does not swell $\left[(\Delta W/W) \text{ goes to zero}\right]$. However, there is no evidence to indicate that this actually happens. At any rate the percent swelling will decrease until a point is reached where continued aging will not affect the swelling properties of the rubber. At this point the slope goes to zero.

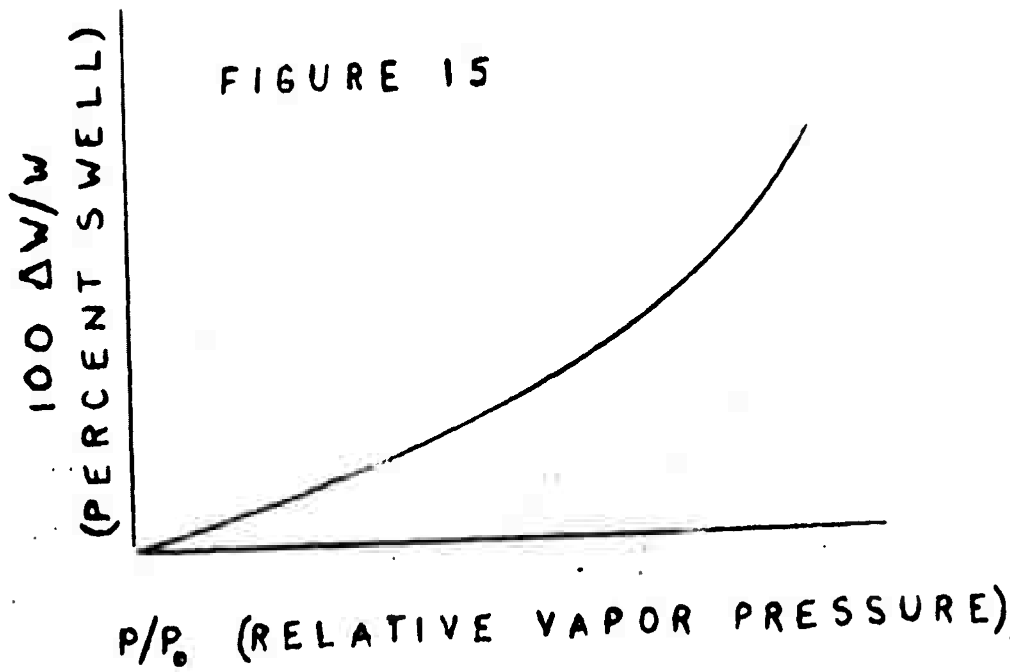
SECTION III

Vapor Phase Swelling Studies with the Quartz Beam Microbalance Apparatus

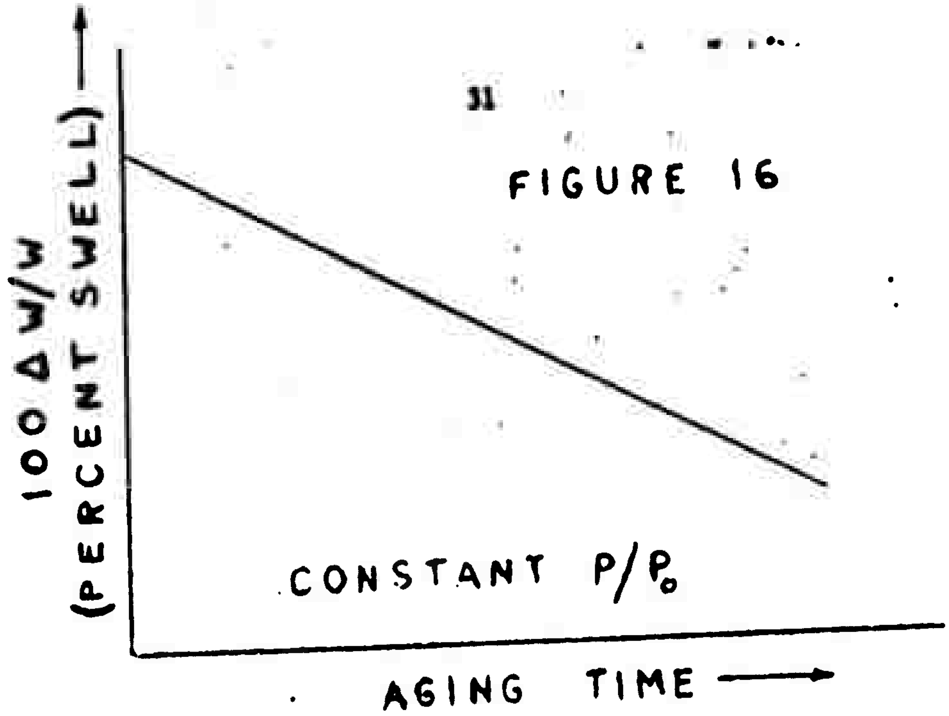
Introduction

The apparatus used in these studies has been described in detail elsewhere. [8] Essentially, the percent swell (100ΔW/W) of the rubber sample is measured as a function of the relative vapor pressure (P/P_o) of the swelling solvent.

The resulting data can be plotted by different methods. The simplest method is shown in Figure 15.



Here, the percent swell of the rubber sample is plotted against the relative vapor pressure of the swelling solvent. Although this graphical method is sensitive to the change in the swelling property with aging, a straight line can be produced by plotting the percent swell of an aged sample (at constant P/P_o) against the time of aging. This relationship is shown in Figure 16.



The equation of the line is given by

$$100\Delta W/W = kt + c \qquad (5)$$

where k is the rate constant for the aging process at constant temperature, t is the duration of aging and c is the percent swell of a non-aged sample at constant P/P_0. The rate constant k is related to the temperature at which the sample was aged by:

$$\log k = \frac{\Delta H}{2.303\ RT} + \alpha \qquad (6)$$

where; T is the absolute temperature, ΔH is the heat of activation for the aging process, R is the gas constant, and α is a constant of integration. It is evident that a linear relationship exists between log k and 1/T. Thus k can be evaluated at the temperature of storage of the rubber sample if two or more values of k are known at higher temperatures. Then the loss in the swelling property at the temperature of storage can be calculated at any time t from equation (5). By combining this data

with the working properties of the rubber, the storage life can be evaluated.

A Comparison of Data for Aged and Non-aged Rubber

The swelling isotherms of rubber O-rings and sheet rubber are shown in Figures 17, 18, and 19 for both aged and non-aged samples. CCl_4 was used as the swelling solvent. It is evident that a decrease in the swelling property occurs under accelerated aging conditions. Complete swelling isotherms were not run on aged rubber O-rings (Figure 19). Instead, the percent swell after different times of aging was measured at only one relative pressure ($0.600 P/P_o$). Two of these points are shown in Figure 19.

By plotting the data as in Figure 16 the rate constants for the aging processes at 70°C can be calculated by equation (5). The graphs are shown in Figures 20, 21, and 22. It should be noted that only two points are available in Figures 20 and 21 (from Figures 17 and 18, respectively). In Figure 22, five points are available, although only three of these are indicated in Figure 19. In all cases the points have been taken at a relative vapor pressure of 0.600. The rate constants are presented in Table VI.

TABLE VI

Rubber Type	Rate Constant at 70°C
HN-81848-R sheet	- 0.031 day^{-1}
HN-80496-DSP2 sheet	- 0.076
SR-822-60 O-rings	- 0.033

The data indicate that HN-81848-R sheet rubber and SR-822-60 rubber O-rings age at about the same rate while HN-80496-DSP2 sheet

FIGURE 17

SWELLING OF BN-81848-R BY CCl_4 AT 20°C

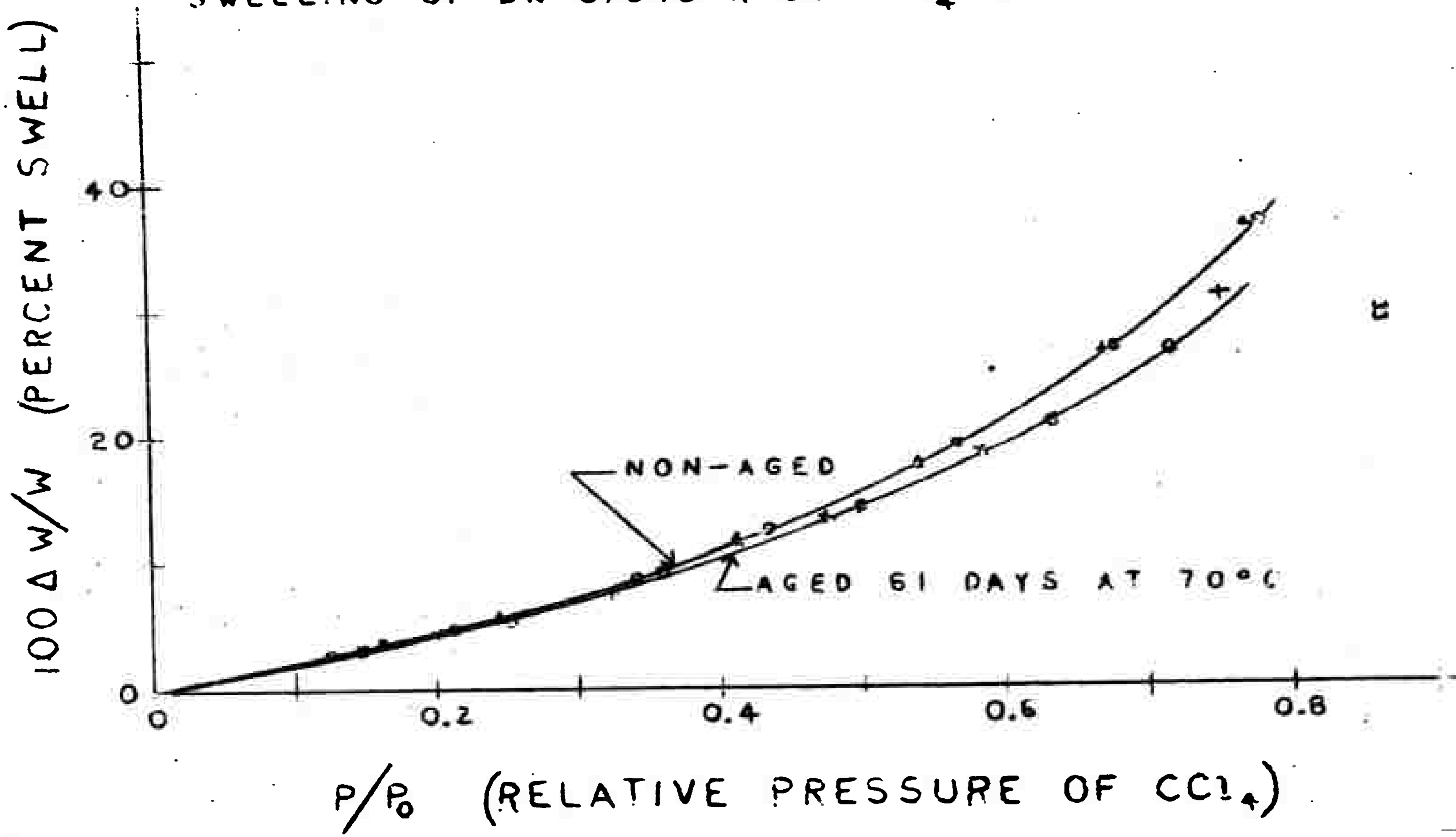


FIGURE 18

SWELLING OF BN-80496-DSP2 BY CCl_4 AT 20°C

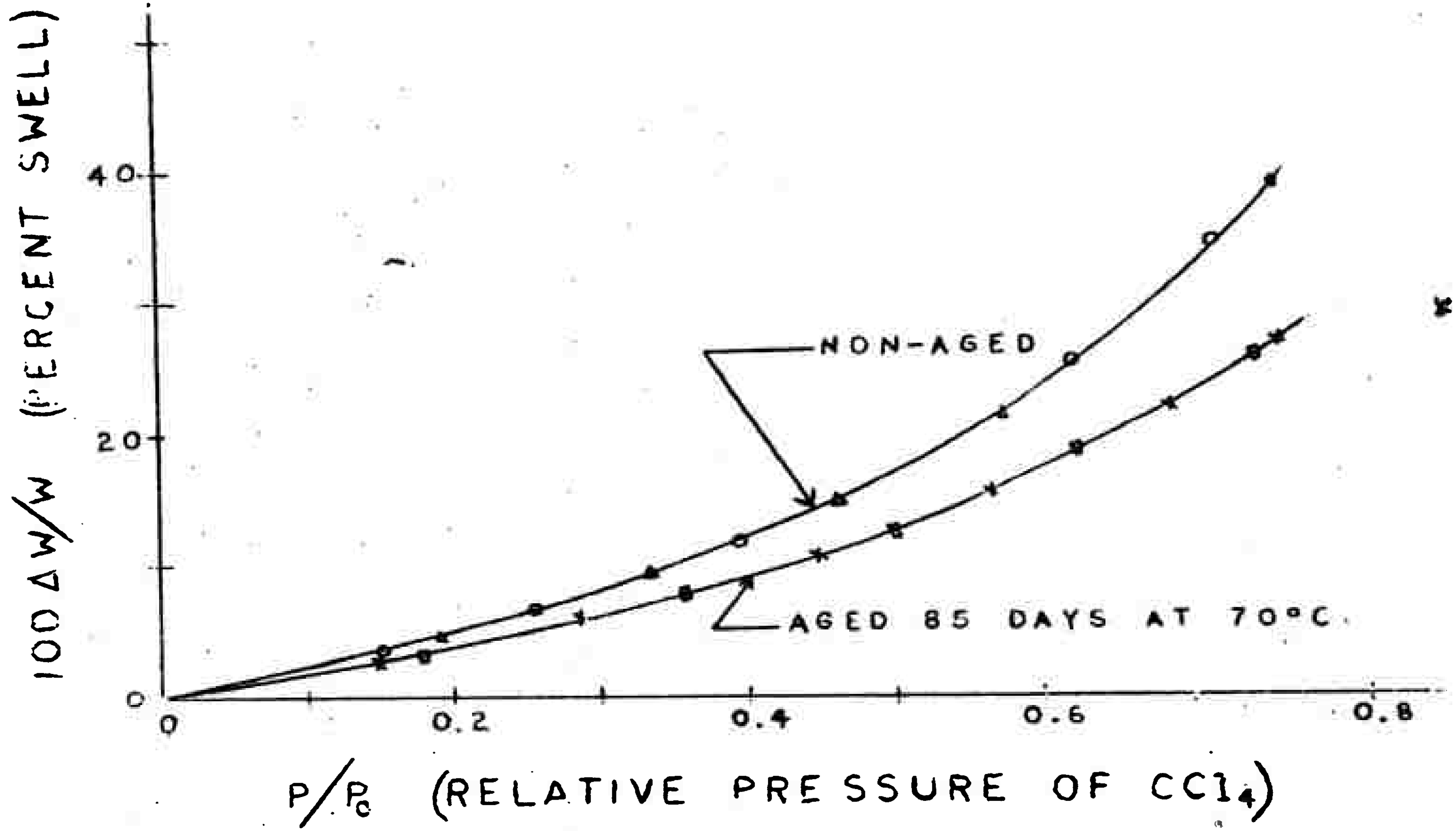


FIGURE 19

SWELLING OF SR-822-60 O-RINGS BY CCl_4 AT 20°C

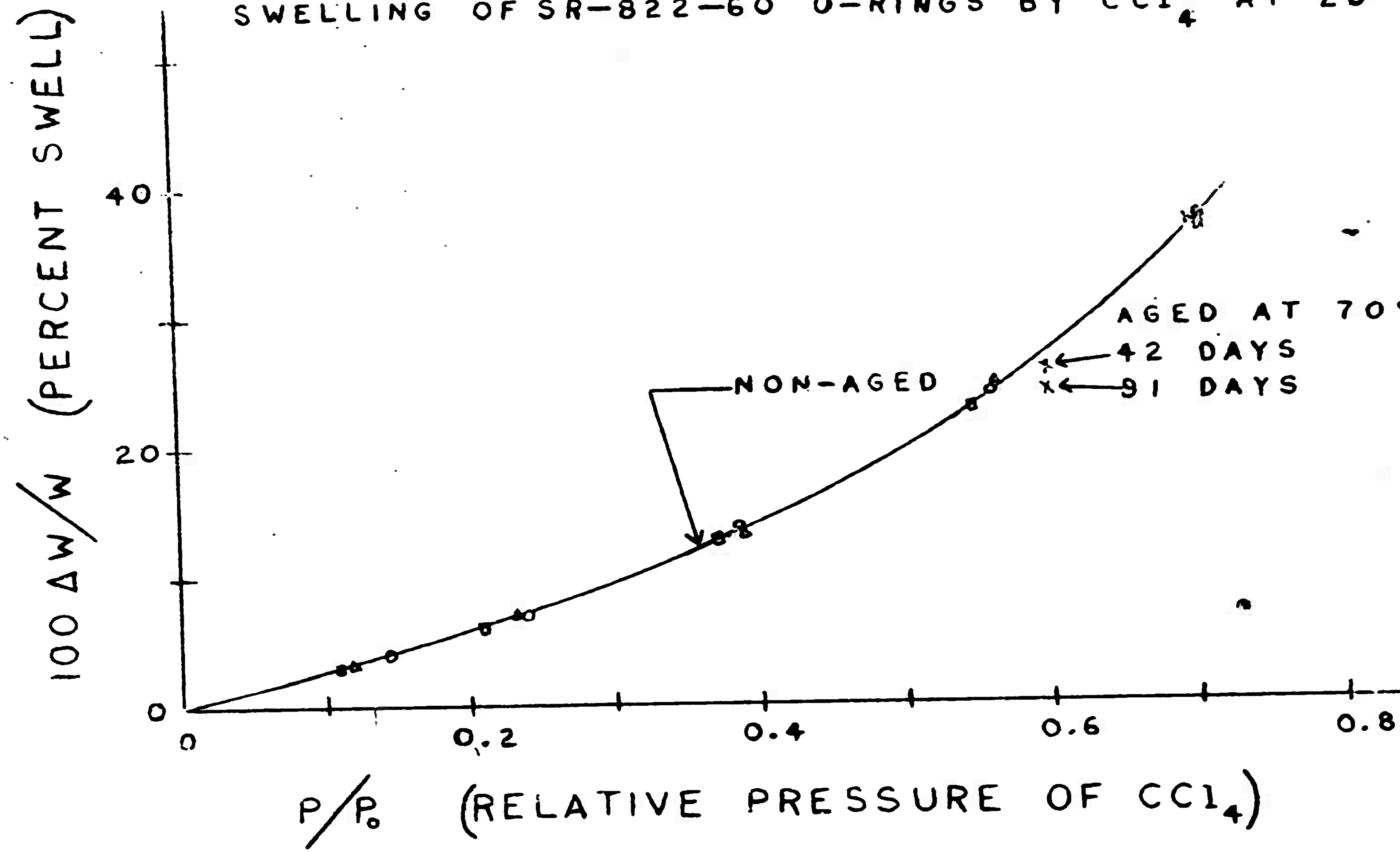
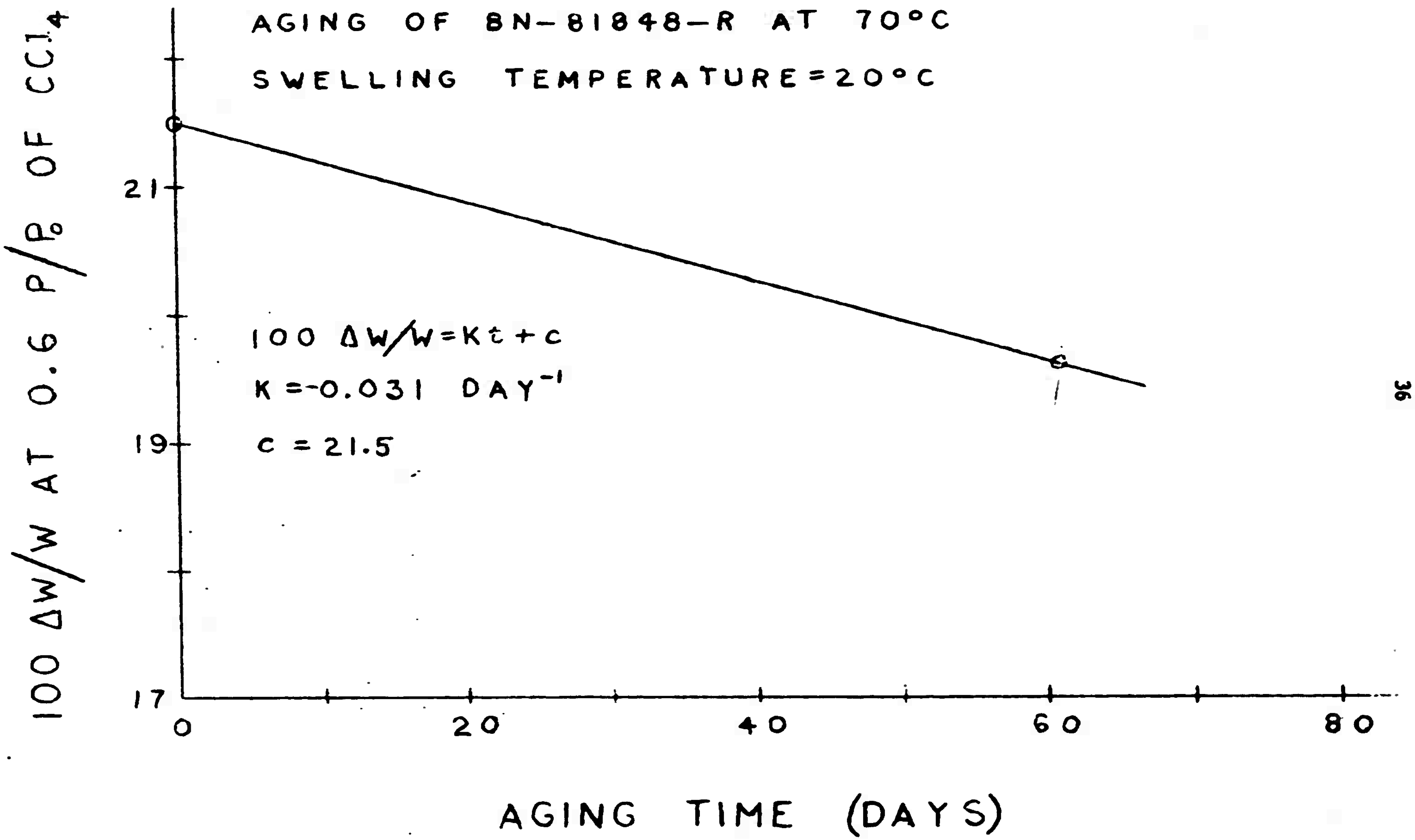


FIGURE 20


AGING OF BN-81848-R AT 70°C
SWELLING TEMPERATURE=20°C
100 ΔW/W=Kt+c
K=-0.031 DAY⁻¹
c = 21.5
100 ΔW/W AT 0.6 P/P₀ OF CCl₄
21
19
17
0
20
40
60
80
AGING TIME (DAYS)

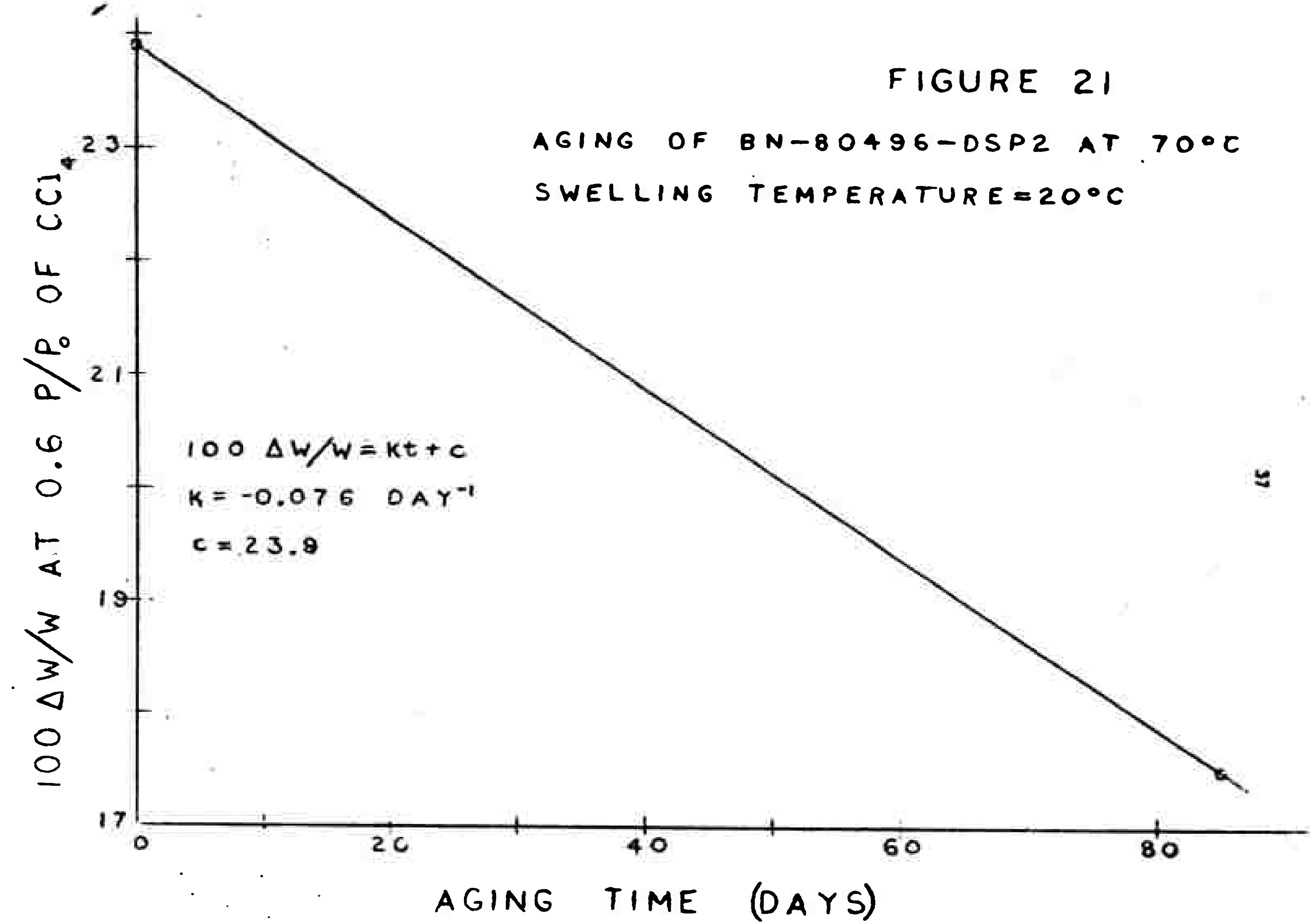
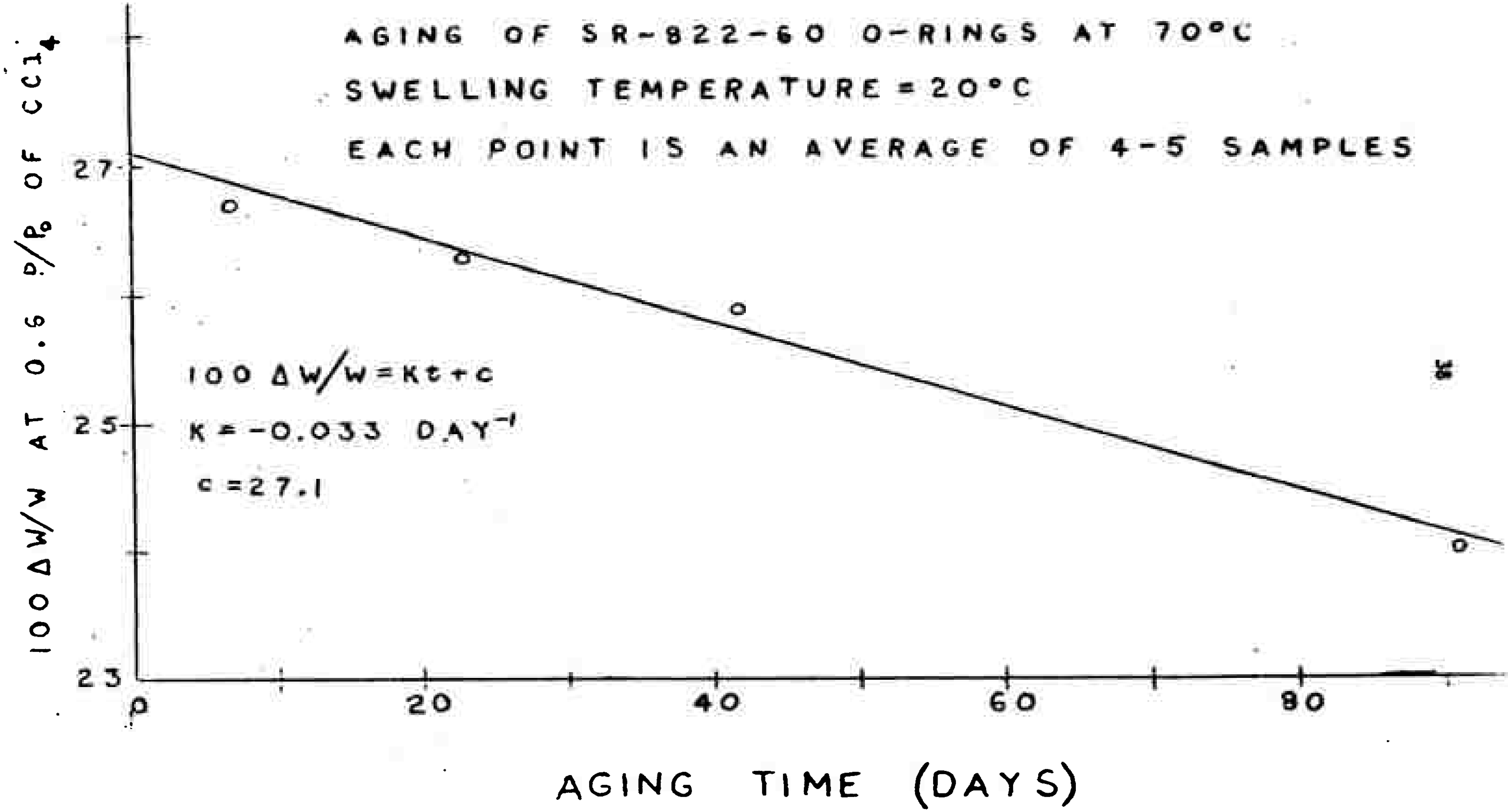


FIGURE 21

AGING OF BN-80496-DSP2 AT 70°C

SWELLING TEMPERATURE = 20°C

FIGURE 22


AGING OF SR-822-60 O-RINGS AT 70°C
SWELLING TEMPERATURE = 20°C
EACH POINT IS AN AVERAGE OF 4-5 SAMPLES
100 ΔW/W = Kt + c
K = -0.033 DAY⁻¹
c = 27.1
27
25
23
0
20
40
60
80
AGING TIME (DAYS)
100 ΔW/W AT 0.6 P/P₀ OF CCl₄

rubber ages more than twice as fast as the other two.

Because the aging data is available at only one temperature ($70^{\circ}C$) the rates of aging at the temperature of storage cannot yet be calculated. Samples of rubber O-rings are presently being aged at $90^{\circ}C$ to allow this calculation.

Theoretical Studies on the Aging Process

A theoretical investigation of the aging process should allow the evaluation of factors responsible for the break-down of rubber and permit the selection of rubber compounds better suited for a particular function. For these reasons an attempt is being made to interpret the swelling data according to the theory of Flory [9]. This theory predicts that swelling data should fit the equation

$$2.303 \log \frac{P/P_o}{1-V_2} - V_2 = X_1 V_2^{\,2} \qquad (7)$$

where P/P_o is the relative vapor pressure of the swelling solvent, V_2 is the volume fraction of the rubber in the rubber-solvent gel, and X_1 is a constant called the mixing parameter. By plotting

$2.303 \log \frac{P/P_o}{1-V_2} - V_2$ against $V_2^{\,2}$ a straight line should result, with a slope equal to X_1. Plots have been made for the swelling data on both aged and non-aged sheet rubber (MM-80496-DSP2). The results are shown in Figures 23 and 24. Although some data scatter is present, the points fall reasonably well on a straight line. For non-aged samples X_1 equals 0.695. For samples aged 85 days at $70^{\circ}C$, $X_1 = 0.895$. Thus, the value of X_1 is sensitive to the break-down of the rubber samples.

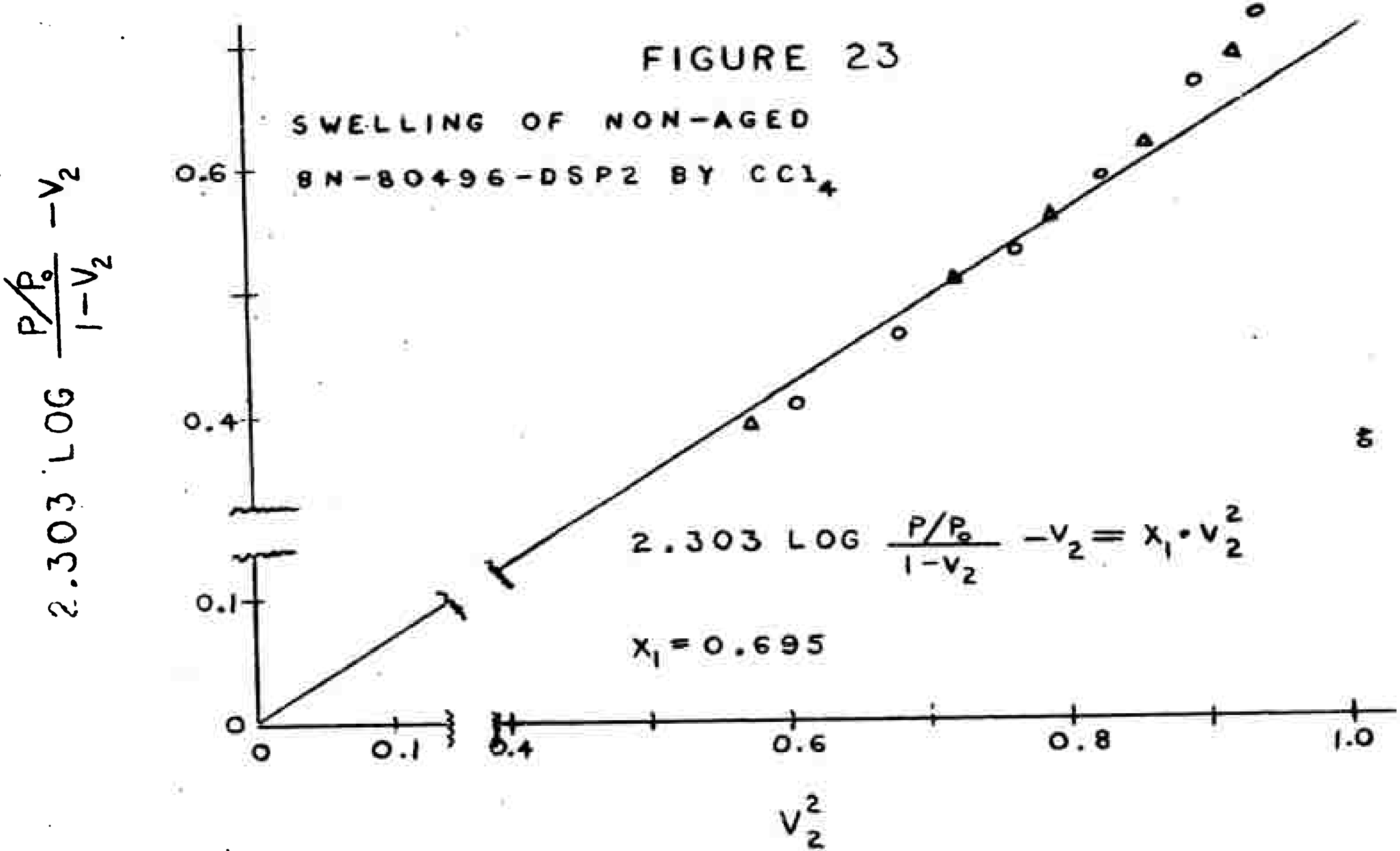
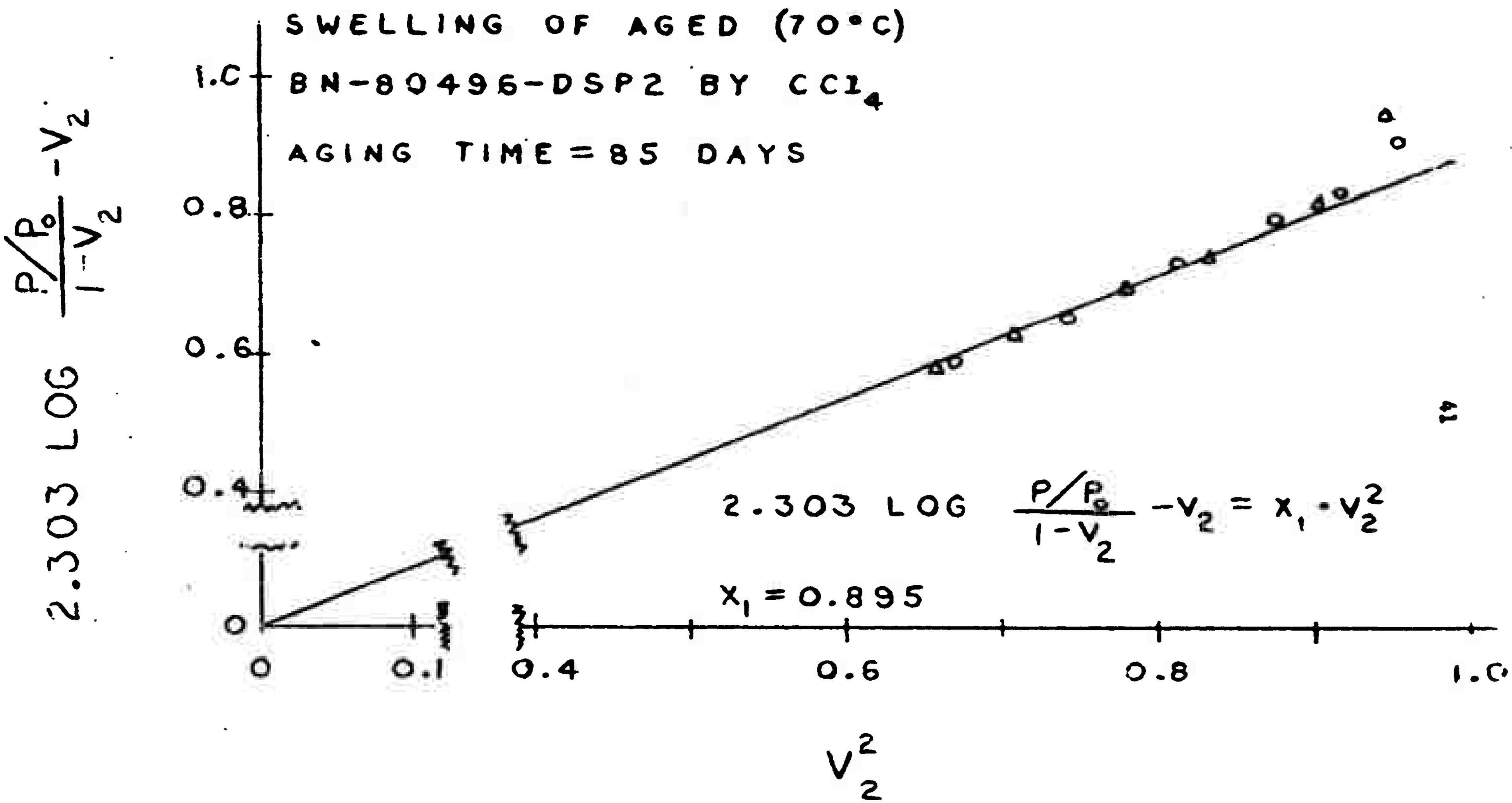


FIGURE 23
SWELLING OF NON-AGED
8N-80496-DSP2 BY CCl_4
$2.303 \log \frac{P/P_0}{1-V_2} - V_2 = X_1 \cdot V_2^2$
$X_1 = 0.695$
$2.303 \log \frac{P/P_0}{1-V_2} - V_2$
V_2^2
0
0.1
0.4
0.6
0.8
1.0
0.1
0.4
0.6

FIGURE 24


SWELLING OF AGED (70°C)
BN-80496-DSP2 BY CCl4
AGING TIME = 85 DAYS
2.303 LOG $\frac{P/P_0}{1-V_2} - V_2$
1.0
0.8
0.6
0.4
0
0.1
0.4
0.6
0.8
1.0
$2.303 \log \frac{P/P_0}{1-V_2} - V_2 = X_1 \cdot V_2^2$
$X_1 = 0.895$
V_2^2

A second means of plotting the data is shown in Figure 25. In this graph the points represent the experimental data and the curves are calculated from the values of X_1. It is evident that the results are different for aged and non-aged samples.

According to the theory, X_1 is related to the heat of dilution, $\Delta \bar{H}_1$, of the solvent in the rubber by

$$\frac{\Delta \bar{H}_1}{RT} = X_1 V_2^{2} \tag{8}$$

where $\Delta \bar{H}_1$ is given by the relationship

$$\log P/P_o = - \frac{\Delta \bar{H}_1}{2.303\ RT} + C' \tag{9}$$

Thus, by measuring P/P_o at constant V_2 as a function of the absolute temperature $\Delta \bar{H}_1$ and X_1 can be calculated. Providing the theory is correct, the value of X_1 as calculated from equation (8) should be the same (within the limits of experimental error) as the value calculated from equation (7). Alternatively, $\Delta \bar{H}_1$ can be calculated (at constant V_2) from equation (8) with the value of X_1 from equation (7). This value of $\Delta \bar{H}_1$ should then correspond to the measured value (from equation 9). Although the experimental technique in measuring $\Delta \bar{H}_1$ has not yet been perfected, the values obtained thus far are definitely of the right magnitude (150-300 cal/mole).

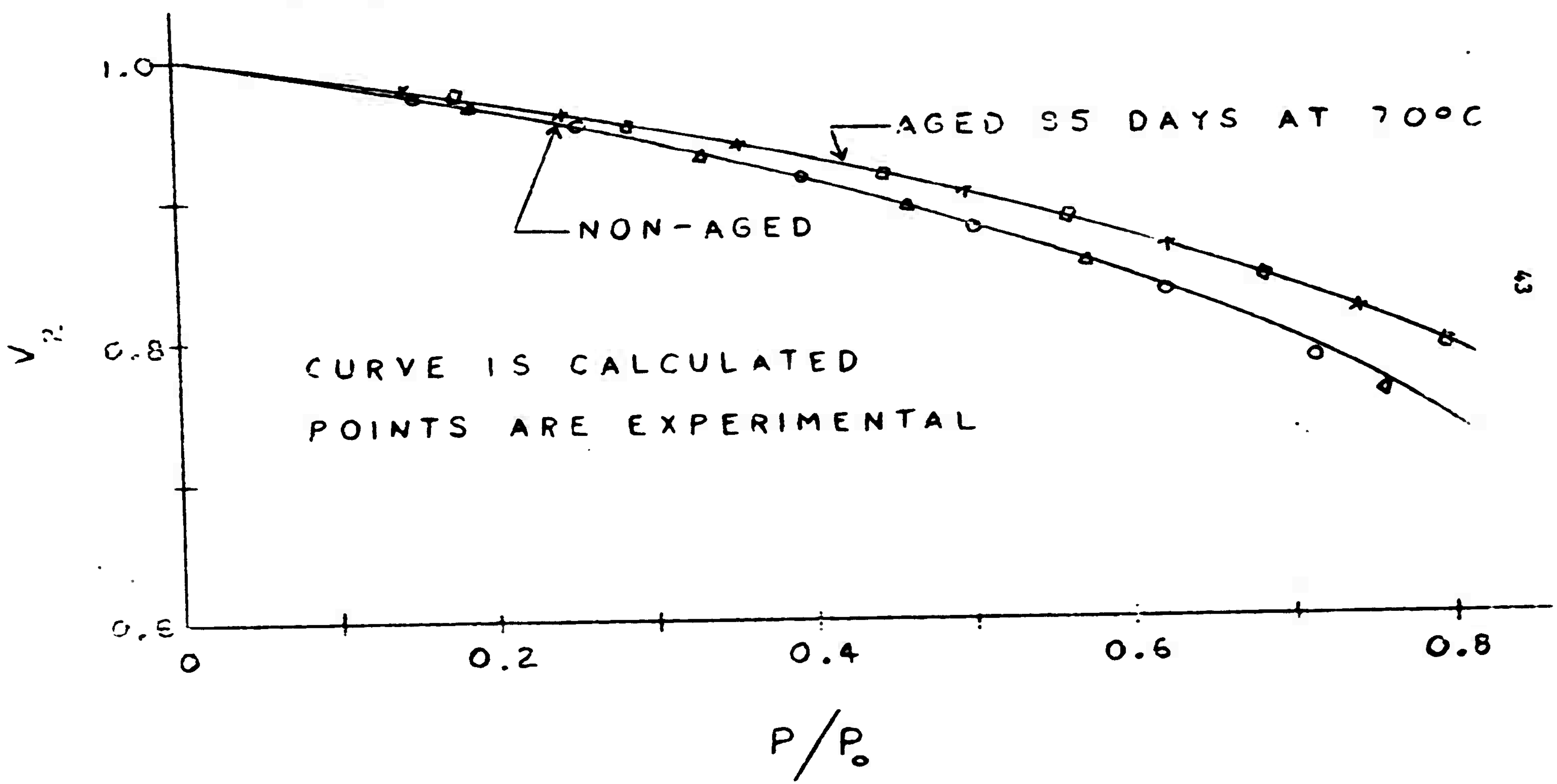
Future Work on Swelling Studies

Heat of dilution measurements will be continued as a further test of the Flory theory. Also, swelling data will be obtained on rubber O-rings aged at different temperatures. With this data the rate of loss in the swelling property at the temperature of storage will be calculated.

FIGURE 25

SWELLING OF BN-80496-DSP2 BY CCl_4

SWELLING TEMPERATURE = 20°C



By combining the swelling data with data on other physico-mechanical properties (modulus, relative elongation, etc.) it should be possible to calculate the storage life of the O-rings.

SECTION IV

Vaporization of Volatile Components

In the Rubber

A rubber sample measuring approximately 1 cm X 2 cm X 2mm and weighing approximately 0.6 gram was suspended in a drying oven maintained at a constant temperature of 70°C. The sample was suspended near the bulb of the thermometer to insure that the temperature in the vicinity of the sample remained at the desired temperature. Air was allowed to circulate freely through the oven by means of an opening in the top of the oven. The sample was removed from the oven at different intervals, allowed to cool in air for ten minutes, weighed with an analytical balance and returned to the oven. The sample used in this study was cut from the same sheet of SR-822-60 rubber that was used to obtain the curves in Figures 13 and 14. Results of this experiment are given in Figure 26, which is a plot of percentage weight decrease of the sample, $-(\Delta W/W)100$, versus aging time in hours.

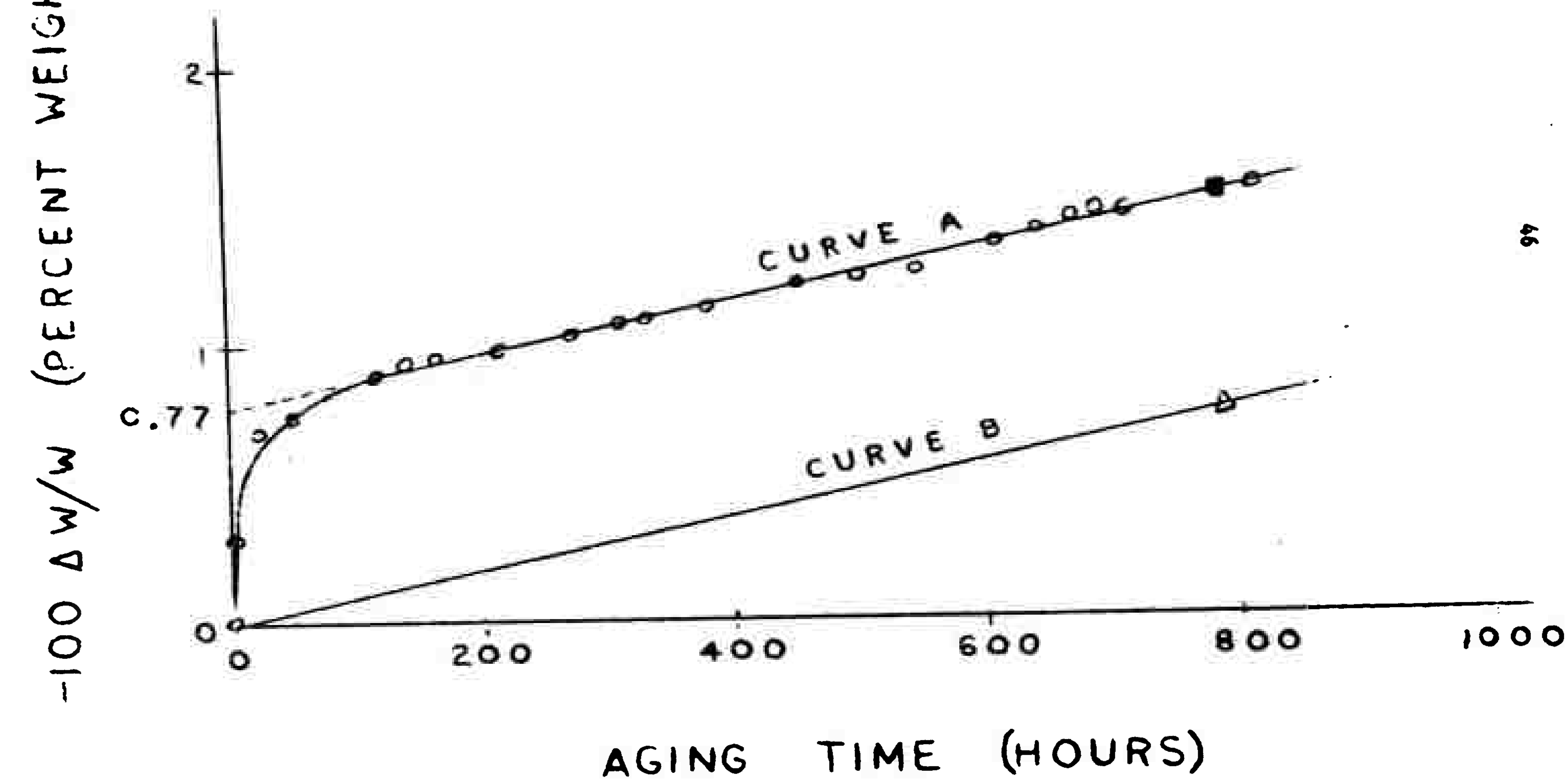
Two curves are shown in Figure 26. Curve A is a plot of the data obtained in the experiment. This curve shows that there is a rapid decrease in weight during the first few hours of aging, probably due to vaporization of moisture and grease picked up by the sample during storage and handling. Beyond this point the curve becomes linear. If one assumes that the first portion of this curve is due to vaporization of grease and moisture (to be verified in future experiments) and that the weight loss with aging time is a linear function as indicated by the remainder of the curve, then the plot can be corrected for the presence of these foreign materials. This is done by extrapolating the linear portion of the curve to zero time, taking another point on curve A and subtracting the value determined by extrapolating the curve to zero time. A straight line can then be constructed through the two points,

FIGURE 26

SR-822-60 SAMPLES AGED AT 70°C

O = DATA CURVE

Δ = TRUE AGING CURVE



one of which becomes the origin. Curve B in Figure 26 is the corrected curve and should be the true volatilization curve. This procedure in no way alters the slope of the line.

SECTION V

Neutron Irradiation of Rubber

In an attempt to learn more about the dependence of swelling on crosslinking several samples were placed in the University of Oklahoma research reactor and bombarded with neutrons.

Two samples of a Buna-N type rubber of the same size and composition as those used in the swelling studies were placed in the reactor at a flux position of 10^8 neutrons/cm^2/second. The samples were bombarded for 240.45 watt-hours, removed from the reactor (radiation level of samples was negligible) and swelled in the modified test tube apparatus for 72 hours using benzene as the solvent at a temperature of 20°C.

In addition to these two samples three control samples that had not been bombarded were swelled under the same conditions. Experimental results are given in Table VII.

Sample 1 was first swelled for 72 hours, allowed to deswell and then was placed in the reactor in an attempt to see if swelling changed the crosslinking or if the presence of solvent molecules during bombarding affected the degree of crosslinking. After being bombarded the sample was again swelled along with the other four samples.

TABLE VII

Bombarded Samples

Sample Number	Weight Before Bombarding (grams)	Weight After Bombarding (grams)	Weight Of Swelled Sample (grams)	Weight Increase (grams)	Percent Weight Increase
1	0.9915	0.9829	1.6925	0.7096	72.19
2	0.9564	0.9564	1.6542	0.6978	72.96

Samples Not Bombarded

Sample Number	Original Sample Weight (grams)	Weight Of Swelled Sample (grams)	Weight Increase (grams)	Percent Weight Increase (grams)
3	0.6885	1.2152	0.5267	76.50
4	0.6109	1.0662	0.4553	74.53
5	0.7503	1.3251	0.5748	76.61

As a control to see if swelling, deswelling and reswelling changed the percent weight increase, sample 5 was subjected to the same conditions as sample 1 but was not bombarded.

Examination of Table VII shows that there appears to be a decided change in the swelling ability of the rubber sample after neutron bombardment. If the bombardment were continued for a sufficiently long period of time enough crosslinking would occur to render the sample brittle and useless. The results obtained when sample 4 was swelled detract from the total results since this sample would make it appear that the percentage swell of all the samples is approximately 74 ± 2%. Further experimentation would be necessary to show that the results from this sample can be disregarded.

Due to the lack of time, money and facilities this study was not pursued past the initial stages. There are many complicating factors that arise in a problem such as this and fruitful results can be obtained only with the proper equipment and an accurate knowledge of the material subjected to irradiation. Since none of these were available when the problem was started it was decided that preliminary studies would be made and then set aside to concentrate on more fundamental work with the intention of returning to this program at a future date if possible.

SECTION VI

Swelling Behavior

Under Stress Conditions

In another experiment designed to study the degree of crosslinking of an elastomer as well as its swelling behavior under stress, a stretching rack was designed that would permit rubber strips to be stretched to any desired elongation. The rack used in this experiment is shown in Figure 27.

The frame, f, is made of aluminum of single piece construction measuring 55 mm X 15 mm X 5 mm. A turnscrew, s, passes through the upper portion, b, of the frame, which also acts as a holding base, and is secured to a movable base, b'. The rubber sample is secured to the frame between base, b, and the removable clamp, r, in the upper portion of the frame and between base b' and removable clamp r' in the lower portion of the frame. Two screws pass through each removal clamp and are screwed into bases b and b' to hold the sample in place. The sample is stretched to the desired elongation by turning screw s, which causes the movable base, b', to move down the frame. The sample can then be swelled by suspending the frame from hook t in the modified test tube apparatus (Figure 9).

When making a determination rubber samples measuring approximately 20 mm X 5 mm X 2 mm were secured to the frame and swelled at zero elongation. The samples were then allowed to deswell, stretched to 100 percent elongation and reswelled. The strain placed on the rubber sample due to stretching and swelling has caused every sample that has been used to date to break. The same results were obtained when a sample was stretched and aged at elevated temperatures. Stretching the sample to an elongation small enough to prevent breakage causes such a small change in the swelling ability of the sample that one can conclude that no change is found within experimental error.

Since aircraft engines and other Air Force equipment using rubber O-rings are stored in 1010 oil until needed it was considered necessary to determine what effect the 1010 oil had on O-rings that were saturated with this oil for long periods of time. In order to do this it was first necessary to find a method for removing the 1010 oil without causing a change in the properties of the rubber due to the method itself.

Placing O-rings saturated with 1010 oil in a reduced atmosphere system had very little effect on the oil because of its low vapor pressure. Heating the system to a temperature of 50°C for five days failed to remove more than a few milligrams of oil from the rings. Since heating the rubber samples changes the properties of the rubber and because such long periods of time are required to remove all the oil in a simple vacuum system this method was considered impractical. Attempts to remove the oil by soaking the rings in organic solvents or exposing the rings to solvent vapors and then evaporating the solvent from the rings under vacuum likewise failed because most organic solvents remove soluble constituents from the rubber along with the 1010 oil. Even soaking the rings in water containing a detergent caused solution of constituents from the rubber.

The method that appears most promising consists of placing the oil soaked rubber sample in a high vacuum system made up of an evacuating chamber, cold trap, mercury diffusion pump and fore pump with a minimum of connections. The rubber samples are placed in the evacuating chamber, held under vacuum for three days and weighed. Experimental results are given in Figure 28, where the sample weight is plotted versus the total number of days the sample was subjected to high vacuum.

SECTION VII

Removal of 1010 Oil from O-Rings

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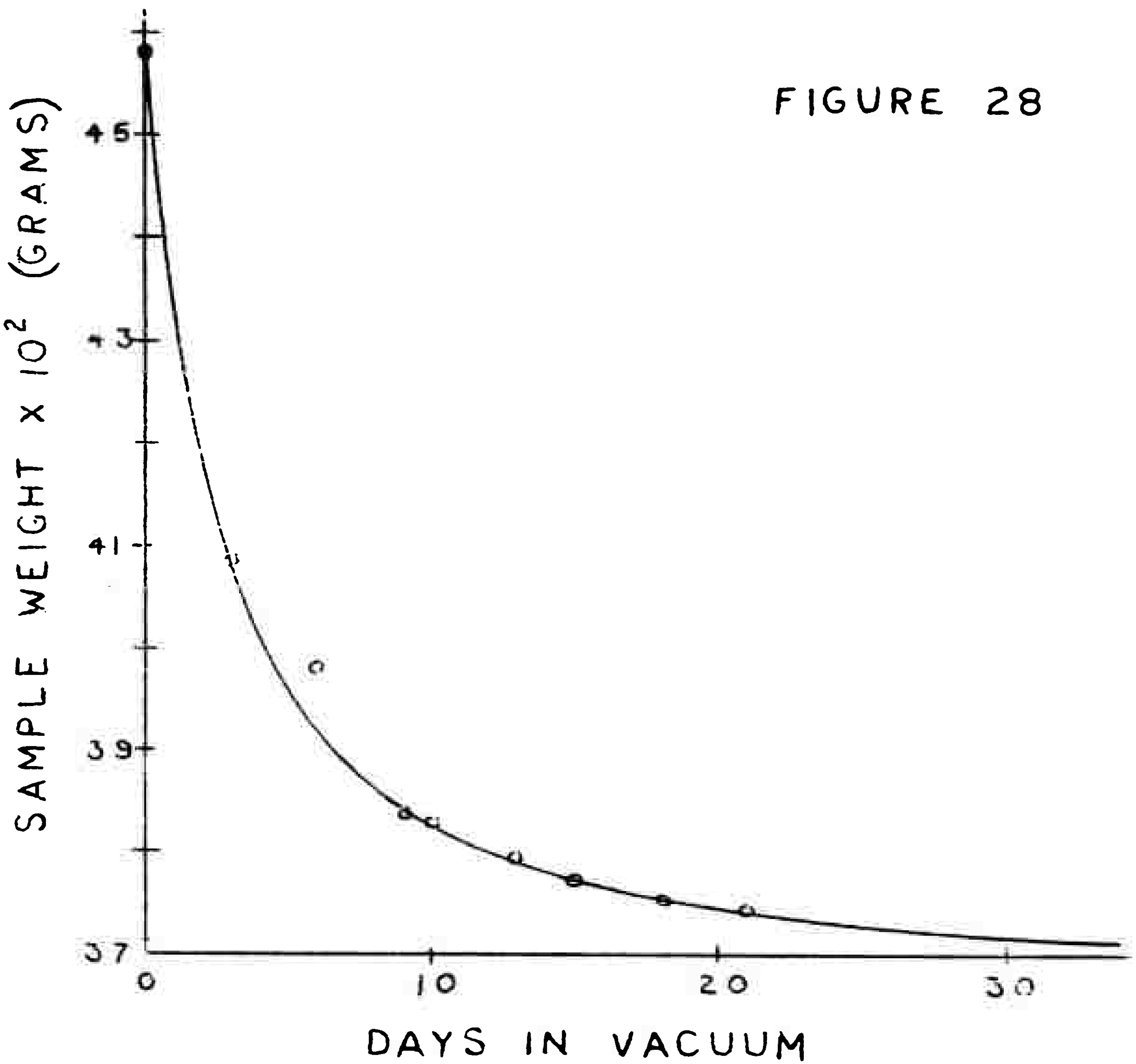
FIGURE 28


SAMPLE WEIGHT x 10² (GRAMS)
45
43
41
39
37
0
10
20
30
DAYS IN VACUUM

According to this graph the sample loses weight rapidly during the first ten days in the system and then gradually approaches a constant weight, achieving this constant weight in about five weeks.

To insure that the vacuum did not remove volatile components from the rubber and thereby change its properties, a control sample that had not been soaked in oil was placed in the vacuum system. At the end of eight days in the system the sample weight had been reduced by approximately 0.8 percent. This weight loss most likely represents the removal of moisture and grease present in the rubber due to handling and storage.

Once this method has been perfected the physical properties of O-rings that have been saturated with 1010 oil and then had the oil removed will be compared with the physical properties of control samples of the same type of rubber that have not been soaked in oil to see what effect the 1010 oil has on the properties of the rubber.

SECTION VIII

Leaching of Constituents from O-Rings

In an attempt to learn more about the effect of accelerated aging on rubber samples a technique was devised to study the material leached from a rubber sample immersed in carbon tetrachloride by means of infrared spectrum analysis. The basis for the experiment was the possibility that aging affected the soluble materials in a definite manner and this change would be evident by changes in the infrared spectrum.

Rubber samples of two different types of Buna-N rubber were heated in air at 70°C for periods ranging from 1 3/4 hours to eight days. The rubber samples measured about 1 cm X 1 cm X 3 mm and weighed approximately 0.4 gram. When a sample was removed from the oven it was allowed to cool overnight, immersed in 50 mls of carbon tetrachloride for 72 hours and removed.

Since the amount of solvent present greatly exceeded the amount of leached material, solvent bands would mask bands due to the soluble material. To eliminate this, and to have a more concentrated solution, the solvent was evaporated by passing a stream of air over the solution contained in a beaker. As soon as the solvent had been completely evaporated the walls of the beaker were washed down with a small amount of solvent and the solution was carefully transferred to a sodium chloride disc where the solvent was again evaporated using compressed air. This was done three times to insure complete transfer of material to the disc. A second sodium chloride disc was placed over the first so the material was contained between the discs. The discs were then placed in a clamp which held the discs in the infrared beam.

Because all the samples used could not be subjected to identical conditions in making these determinations it was necessary to find an internal standard that could be used as a comparison against all other peaks in the spectrum. In other words it was necessary to find a peak that remained constant in relation to the other peaks in the same spectrum.

Extensive tests have been made using this technique but to date no definite correlation has been found between the infrared spectrum of the leached materials and the aging time. It is suspected that the reason for this is the difficulty involved in trying to duplicate the same conditions from sample to sample. The weights vary from sample to sample and may introduce some error although use of an internal standard should eliminate this. The most probable cause for error arises in transferring the solution from the beaker to the disc. In future studies a technique will be devised to eliminate this step from the procedure.

SECTION IX

Temperature Retraction Apparatus

The Temperature Retraction test (ASTM D 1329-60) provides a method for rapid evaluation of crystallization effects and for comparing viscoelastic properties of rubber and rubber-like materials at low temperatures.

Apparatus

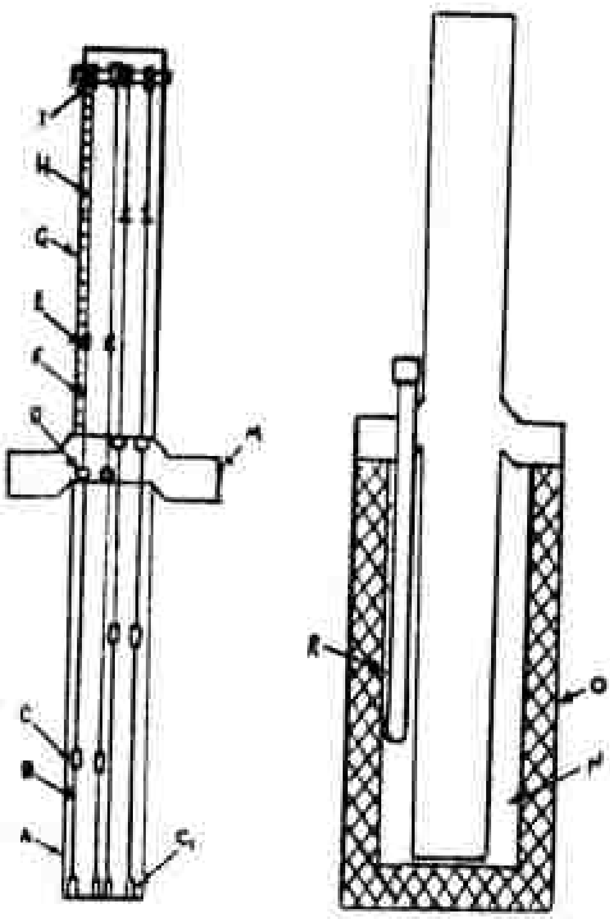
The testing apparatus consists of a specimen rack, an insulated cooling bath which is equipped with a thermometer, an immersion heater, and a liquid coolant. A schematic drawing of the apparatus is shown in Figure 29. The specimen rack was designed so that it maintains a slight tension (1 to 3 psi) on the specimens and permits them to be stretched and anchored at any elongation up to a maximum of 250 percent. The length of the specimens can be read by an indicator at any time during the test within an accuracy of $\pm$ 0.05 centimeters. The rack was designed so that it can hold four specimens at the same time.

The bath consists of a silvered Dewar flask which sets in a wooden box. The liquid coolant equilibrium mixture used is methanol and dry ice.

Procedure

The Dewar flask is filled three-fourths full with the methanol-dry ice equilibrium mixture at about - 70°C by adding chopped dry ice to methanol. One end of the test specimens are inserted into the stationary clamp at the bottom of the sample rack and the other end in the movable clamp. The three inch samples are then stretched to the desired length and anchored in the elongated position by tightening the thumb nuts. The specimen rack is placed in the bath slowly to avoid frothing.

FIGURE 29



A - Specimen Rack

B - Test Specimen

C - Movable Clamp

C_1 - Stationary Clamp

D - Thumb Nut

E - Indicator

F - Connecting Wire

G - Graduated Scale

H - Flexible Cord

I - Pulley

M - Rack Support

N - Bath

O - Wooden Container

R - Heater

If the temperature of the bath rises above - 70°C when the rack is inserted, a small amount of dry ice is added to reduce the temperature to between - 70° and - 73°C. After 10 minutes the thumb nuts are released, and the specimens are allowed to retract freely. At this point the heater is turned on. The first reading is taken at - 70°C, and continued at two minute intervals until retraction is complete.

Preliminary Results

Data is given below in Table VIII and in Figure 30 on three Buna-N rubber samples of different cure date (not the same rubber compound in all three samples). Three inch samples are given an initial elongation of five centimeters (65.7% testing elongation) and placed in a methanol-dry ice bath at - 70°C for 10 minutes. The samples are then released and allowed to retract.

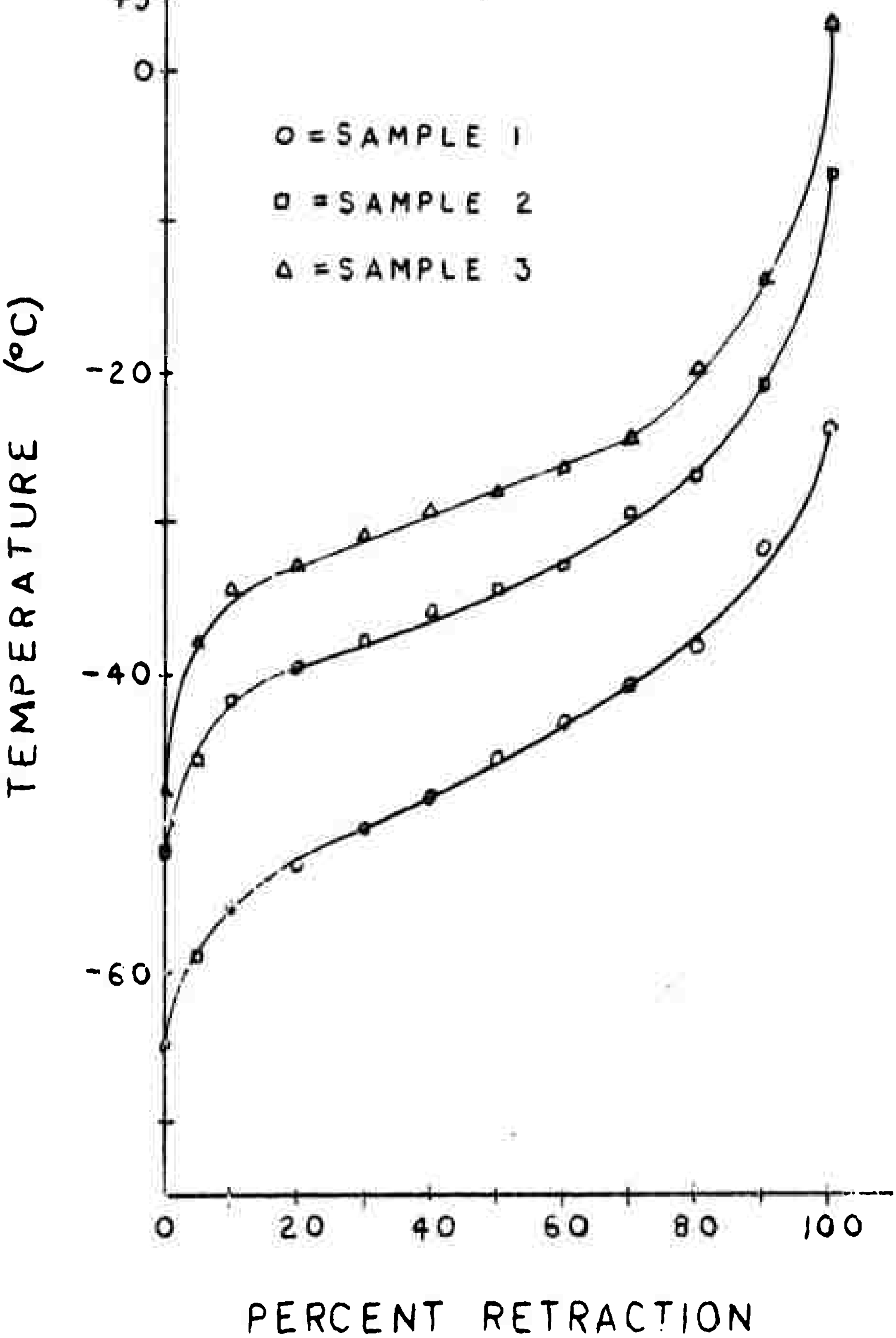
TABLE VIII

Sample Number	1	2	3
Cure Date	1-61	1-54	5-56
TR 10	-55.8°C	-42°C	-34.6°C
TR 30	-50.4	-37.7	-30.8
TR 50	-45.8	-34.7	-28.0
TR 70	-41.0	-29.6	-24.5
(TR 70 - TR 10)	14.8	12.4	10.1
Freezing Point	-59	-44.5	-36

Future Work

Since the difference between the temperature at which a vulcanizate retracts 10 percent (TR 10) and the temperature at which a vulcanizate retracts 70 percent (TR 70) increases as the tendency to crystallize increases, sample no. 1 crystallizes before sample no. 2; and sample no. 2 crystallizes before sample no. 3.

FIGURE 30


○ = SAMPLE 1
□ = SAMPLE 2
△ = SAMPLE 3
TEMPERATURE (°C)
+5
0
-20
-40
-60
0
20
40
60
80
100
PERCENT RETRACTION

The temperature retraction test will be performed on samples that have undergone accelerated aging. It is believed that measurable changes will occur in (TR 70 - TR 10) and hence represent an indication of the degree of aging.

SECTION X

Bibliography

SECTION X

Bibliography

BIBLIOGRAPHY

1. Youmans, R.A. and Maassen, G.C.: "Correlation of Room Temperature Shelf Aging with Accelerated Aging", Industrial and Engineering Chemistry, Vol. 47, July 1955.

2. Juve, A.E. and Schoch, M.G.: "The Effect of Temperature on the Air Aging of Rubber Vulcanizates", ASTM Bulletin No. 195, January 1954.

3. Schoch, M.G. and Juve, A.E.: "The Effect of Temperature on the Air Aging of Rubber Vulcanizates", ASTM STP No. 89, 1949.

4. Juve, A.E. and Schoch, M.G.: "The Effect of Temperature on the Air Aging of Rubber Vulcanizates", Unpublished, 1960.

5. Mandel, J., Roth, F.L., Steel, M.N. and Stiehler, R.D.: "Measurement of the Aging of Rubber Vulcanizates", Journal of Research of the NBS, Vol. 63C, No. 2, Oct-Dec 1959.

6. Holloway, J.M. et al: Rubber Laboratory Progress Report, Mare Island Naval Shipyard, Vallejo, California, 1941.

7. Reinhart, F.W.: Degradation of Plastics, Nat. Bur. of Standards Circular.

8. Christian, S. et al: Final Report, Contract AF 34(601)-5233 Project Authorization 14, Appendix D.

9. Flory, P.J.: Principles of Polymer Chemistry, Cornell Univ. Press, Ithaca, 1953.

SECTION XI

Literature Bibliography

X-RAY STUDIES, INFRARED STUDIES

MASS SPECTROMETRY, ELECTRON MICROSCOPE

BIBLIOGRAPHY

Achhammer, B. G., Reiney, M. J., Wall, L. A., Reinhart, F. W., Study of Degradation of Polystyrene by Means of Mass Spectrometry; J. Polymer Sci., 8:555 (1951)

Achhammer, B. G., Reiney, M. F., Reinhart, F. W., Study of Degradation of Polystyrene, Using Infrared Spectrophotometry; J. Research Nat. Bir. Standards, 47:116 (1951)

Achhammer, B. G., Reiney, M. J., Wall, L. A., Reinhart, F. W., Study of Degradation of Polystyrene, Using Mass Spectrometry; Poly. Degradation Mechanisms, Nat. Bureau Stds., Cir. 525 (1953)

Alexander, L. E., Michalik, E. R., X-Ray Diffraction by Assemblages of Line Scatterers with Application to Linear Polymers, Acta. Cryst., 12:105 (1959) .

Andrews, E. H., Walsh, A., Rupture Propagation in Inhamogeneous Solids: Electron Microscope Study of Rubber Contg. Colloidal C Black, Proc. Phys. Soc., 72:42 (1958)

Alexander, L. E., Ohlberg, S., Taylor, R. G., X-Ray Diffraction Studies of Crystallization in Elastomers; I. Appl. Phys., 25:1068 (1955)

Andrews, E. H. and Walsh, A., The Rupture Process in Carbon-Loaded Rubbers: An Electron Microscopic Investigation, J. Polymer Sci., 1, 33, 39, (1958)

Anderson, R. B., Emmett, P. H., Measurement of Carbon Black Particles by the Electron Microscopy and Low Temperature Nitrogen Absorption Isotherms; J. Appl. Phys., 19:367 (1948)

Anderson, R. F., A Method for Eliminating Gross Artifacts in Drying Specimens; Extrait du Congres De Microscopie Electronique, Editions de la Reyue D'Optique, Paris (1952)

Anderson, T. F., Preparation and Preservation of Biological Specimens. 20. Preservation of Structure in Dried Specimens; Presented at the Proceedings of Inter. Conf. of Electron Microscopy, London (1954)

Anderson, T. F., The Use of Critical Point Phenomena in Preparing Specimens for the Electron Microscope, J. Appl. Phys., 21:724 (1951)

Avery, W. H., Morrison, J. R., Invrared Spectra of Hydrocarbons Part II. Analysis of Octane Mixtures by the Use of Infra-Red Spectra Obtained at Low Temperatures: J. Appl. Phys., 18:969 (1947)

Baker, W. O., Fuller, C. S., Pape, N. R., The Crystallinity of Cellulose Esters, J. am. Chem. Soc., 64:776 (1942)

Barnes, R. B., McDonald, R. S., Williams, V. F., Small Prism Infra-Red Spectrometry; J. Appl. Phys., 16:77 (1945)

Barnes, R. B., Liddel, U., Williams, V. F., Synthetic Rubber, A Spectroscopic Method of Analysis and Control; Ind. Eng. Chem. 15:83 (1943)

Bartkowski, H., Infrared Spectroscopic Analysis of Rubber and Plastics; Kautschuk U. Gummi, 13:wt262 (1960)

Berreman, D. W., A Single Quartz Crystal Point Focusing X-Ray Monochromator; Presented to the Nat. Acad. Of Sc., Calif. Inst. of Tec.; (Nov. 1955)

Berreman, D. W., DuMond, J. W. M. Marmier, P. E., New Point Focusing Monochromator, Rev. Sci. Instr., 28:960 (1957)

Berreman, D. W., Single Quartz Crystal Point Focusing X-Ray Monochromator; Rev. Sci. Instr., 26:1048 (1955)

Bunn, C. W., Parrish, W., X-Ray Analysis X-Ray Diffraction, X-Ray Fluorescence Spectrography; Encyclopedia Chem. Technol. 15:158 (1956)

Bierlein, T. K., Mastel, B., Optical and Electron Microscope Examination of Preselected Areas; Rev. Sci. Instr., 28:960 (1957)

Binder, John L., Ransaw, H. C., Analysis of Polyisioprenes by Infrared Spectroscopy; Anal. Chem., 29:503 (1957)

Birks, L. S., Brooks, E. J., An Electron Probe X-Ray Microanalyzer; Report of NRL Progr., (May 1957)

Birks, L. S., Brooks, E. J., Bourlay, G. W., Compact Curved-Crystal X-Ray Spectrometer; Rev. Sci. Instr., 29:425 (1958)

Birks, L. S., Brooks, E. J., X-Rays Lighten the Analytical Load; Anal. Chem., 30:19 (1958)

Bishop, F. W., A Revolving Specimen Stage for the Electron Microscope; Rev. Sci. Instr., 23:504 (1952)

Bishop, F. W., An Electron Gun Mocification for the Control of Beam Current in the RCA Electron Microscope; Rev. Sci. Instr. 24:73 (1953)

Bishop, F. W., Cook. M. L., Coupled Through-Focus Control for the RCA Type EMU-2B Electron Microscope; Rev. Sci. Instr. 24:1064 (1953)

Bishop, F. W., Exposure Timer for the Electron Microscope; Electronics, (Mar. 1955)

Bishop, F. W., External Condenser Aperture-Centering and Inter-Changing Device for the RCA EMU Electron Microscope; Rev. Sci. Instr., 25:188 (1954)

Black, E. D., Margerum, J. D., Wyman, C. M., Sample Handling for Qualifitive Infrared Microspectroscopy; Anal. Chem., 29:169 (1957)

Boyer, R. F., Heidenreich, R. D., Molecular Weight Studies on High Polymers with the Electron Microscope; J. Apol. Phys., 16:621 (1945

Bradford, E. B., Vanderhoff, J. W., Electron Microscopy of Monodisperse Latexes; J. Appl. Phys., 26:864 (1955)

Bradford, E. B., Electron Microscope Study of Plasticized Latices; J. Appl. Phys., 23:609 (1952)

Bradford, E. B., Vanderhoff, J. W., Alfrey, T., The Use of Monodisperse Latexes in an Electron Microscope Investigation of the Mechanism of Emulsion Polymerization; J. Colloid Sci., 11:135 (1956)

Brattain, R. R., Beeck, O., A Rapid Infra-Red Method for Hydrocarbon Mixtures and a Routine Spectrophotometer for Plant Control, J. Appl. Phys., 13:699 (1942)

Brown, O. E., Charts for Computation of d-Values in X-Ray Diffraction Chemical Analysis; J. Appl. Phys., 18:191 (1947)

Buerger, M. J., Generalized Microscopy and the Two-Wave-Length Microscope, J. Appl. Phys., 21:909 (1950)

Bus, E. E., Reynolds, W. B., Fryling, C. F., McMurrey, H. L., X-Ray Studies of Low-Temperature Polybutadiene and Butadiene-Styrene Copolymers, J. Polymer Sci., 3:4 (1948)

Chambers, F. W., Cole, H., Convenient X-Ray Tube Mount for Two-Crystal Spectrometer; Rev. Sco. Instr., 28:465 (1957)

Chernock, W. P., Beck, P. A., Analysis of Certain Errors in the X-Ray Reflection Method for the Quantitative Determination of Preferred Orientations; J. Appl. Phys., 23:341 (1952)

Chernick, W. P., Meuller, M. H., Fish, H. R., Beck, P. A., An Automatic X-Ray Reflection Specimen Holder for the Quantitative Determination of Preferred Orientation; Rev. Sci. Instr., 24:925 (1953)

Clark, G. J., X-Ray Studies of Rubber, III. A Comparison of Two High Gum Compounds Containing Respectively Sulfur and Tuads as Vulcanizing Agents: Vanderbilt News, 11 : 4 (May, Jun. 1941)

Clark, G. L., Kabler, M., Blaker, E., Ball, J. M., Hysteresis in Crystallization of Stretched Vulcanized Rubber from X-Ray Data; Correlation with Stress-Strain Behavior & resilience; Ind. Eng. Chem., 32:1474 (Nov. 1940)

Clark, G. L., LeTourneau, R. L., Ball, J. M., X-Ray Study of Reactions Involving Accelerators: Orientation of Crystalline Phases on Stretching of Rubber Stocks; Ind. Eng. Chem., 35:198 (1943)

Clark, G. L., LeTourneau, R. L., X-Ray Studies of Rubber; Part IV. Finely Divided Crystalline Fillers, Especially a comparison of Kalvan and Gilder's Whiting; Vanderbilt News, 11:4 (1941)

Clark, G. L., Rhodes, H. D., Practical Evaluation of Commercial Rubber Carbon Blacks by X-Ray Diffraction; Ind. Eng. Chem., 21:66 (1940)

Clark, G. L., Cross, S. T., Smith, W. H., X-Ray Diffraction Patterns of Crystalline Sol Rubber Prepared From Ethereal Solution: J. Research Nat. Bur. Standards, 22:105 (Jan 1939)

Clark, G. L., X-Ray Structure of Vulcanized Rubber; Ind. Eng. Chem., 31:1397 (1939)

Clews, C. J. B., X-Ray Study of Isoprene, Butadiene and Chloroprene at Low Temperature; Nature, 141:513 (1938)

Clews, C. J. B., X-Rays and Rubber; Trans. Inst. Rubber Ind. 18:225 (1943)

Cornish, P. J., (Dunlop Research Center, For Dunlop, Engl.), Identification and Analysis of Polyurethane Rubbers by Infrared Spectroscopy, Anal. Chem., 31:1298 (1959)

Corish, P. J., Infrared Spectroscopic Studies of Ultrathin Microtomed Sections of Polymers. I. Characterization and Structure Determinations of Cured, Black-Loaded Rubbers; J. Appl. Polymer Sci., 4:86 (1960)

Cross, L. H., Richards, R. B., Willis, H. A., The Infra-Red Spectrum of Ethylene Polymers; Discussing Faraday Soc., 9:235 (1950)

Dowling, P. H., Hendee, C. F., Kohler, T. R., Parrish, W., Counters For X-Ray Analysis; Philips Tech. Rev., 18:262 (1957)

Ellis, S. G., Specimen Charging in the Electron Microscope and Some Observations on the Size of Polystyrene Latex Particles; J. Appl. Phys. 23:728 (1952)

Evans, M. B., Higgins, G.M.C., Turner, D. T., Radiation Cross-Linking of Rubber. IV. Ultraviolet and Infrared Absorption Spectra; J. Appl. Polymer Sci., 2:340 (1959)

Farbenfabriken Bayer Akt.-Ges., Stable Polychloroprene; Brit. 843,906 (Aug 10, 1960)

Field, J. E., An X-Ray Study of the Propertion of Crystalline and Amorphous Components in Strectched Rubber; J. Appl. Phys. 12:23 (Jan. 1941)

Field, J. E., Woodford, D. E., Gehman, S. D., Infrared Study of the oxidation of Elastomers; Rubber Chem and Technol., 28:770 (1955)

Fox, R. E., Negative Ion Formation in Hydrogen Chloride by Electron Impact; J. Chem. Phys., 26:1281 (1957)

Field, J. E., Woodford, D. E., Gehman, S. D., Application of Infra-Red Methods in the Structural Examination of Synthetic Rubber; J. Appl. Phys. 17:386 (1946)

Fox, R. E., Hickam, W. M., Kjeldaas, T., Grove, D. J., Direct Measurement of Appearance Potential and Ionization Probability Using a Mass Spectrometer; Paper presented at Symposium on Mass Spectroscopy in Physical Research, Nat. Bureau Stds., Sept, 1951

Fox, R. E., Hickam, W. M., Grove, D. J., Kjeldaas, T., Ionization in a Mass Spectrometer by Monoenergetic Electrons; Rev. Sci. Instr., 26:1101

Fry, D. L., Nusbaum, R. E., Randall, H. M., The Analysis of Multicomponent Mixtures of Hydrocarbons in the Liquid Phase by Means of Infrared Absorption Spectroscopy; J. Appl. Phys., 17:150 (1946)

Fuller, C. S., Baker, W. O., Structure of Synthetic Chain Polymers as Shown by X-Rays; J. Chem. Educ., 20:3 (1943)

Fuller, C. S., Baker, W. O., Pape, N. R., Crystalline Behavior of Linear Polyamides; J. Am. Chem. Soc., 62:3275 (1940)

Gehman, S. D., Fields, J. E., Observations on the X-Ray Structure of Rubber and the Size and Shape of Rubber Crystallite; J. Appl. Phys., 15:371 (1944)

Gehman, S. D., Field, J. E., X-Ray Structure of Rubber-Carbon Black Mixtures; Ind. Eng. Chem., 32:1401 (1940)

Hall, E. C., Electron Densitometry of Stained Virus Particles; Biophys. Biochem. Cyt., 1:1 (1955)

Hall, C. E., Scattering Phenomena in Electron Microscope Image Formation; J. Appl. Phys., 22:655 (1951)

Hall, C. E., Inove, T., Experimental Study of Electron Scattering in Electron Microscope Specimens; J. Appl. Phys. 28:1346 (1957)

Hamm, F. A., an Electron Microscope Photometer; Rev. Sci. Instr., 22:895 (1951)

Hanson, E. E., Daniel, J. H., An Instrument for Measuring Particles Diameters and Constructing Histograms from Electron Micrographs; J. Appl., 18:439 (1947)

Hanson, E. E., Halverson, G., X-Ray Diffraction Study of Some Synthetic Rubbers at Low Temperatures; J. Am. Chem. Soc., 70:779 (1948)

Harvey, M. R., Stewart, J. E., Achhammer, B. G., Index of Refraction and Particle Size as Factors in the Infrared Spectrophotometry of Polyvinyl Chloride; J. Research Nat. Bur. Standards, 56:225 (1956)

Hauser, E. A., LeBeau, D. S., Microscopic Studies of Lyogels: Ultra-Illumination by Incident Light; Ind. Eng. Chem., 37:786 (1945)

Hauser, E. A., LeBeau, D. S., Microscopic Studies of Lyogels: III. Vulcanization of Rubber; J. Phys. Chem., 50:171 (1946)

Hauser, E. A., LeBeau, D. S., Microscopic Studies of Lyogels; Preparation of Samples for Ultra-Illumination by Incident Light; Ind. Eng. Chem., 38:335 (1946)

Heidenrich, R. D., Sturkey, L., Crystal Interference Phenomena in Electron Microscope Images; J. Appl. Phys., 16:97 (1945)

Heindenreich, R. D., Methods in Electron Microscopy of Solids; Rev. Sci. Instr., 23:583 (1952)

Henke, B., DuYond, J. W. M., Low Angle X-Ray Diffraction with Long Wavelengths; Phys. Rev., 89:1300 (1953)

Hickam, W. M., Fox, R. E., Electron Attachment in Sulfur Hexafluoride Using Monoenergetic Electrons; J. Chem. Phys., 25:642 (1956)

Hillier, J., An Objective for Use in the Electron Microscopy of Ultra-Thin Sections; J. Appl. Phys. 22;135 (1951)

Hillier, J., Ultra-Thin Sections for the Electron Microscopy of Tissues; Trans. N.Y. acad. Sci., 13:128 (1951)

Hillier, J., Baker, R. F., On the Improvement of Resolution in Electron Diffraction Cameras; J. Appl. Phys. 17:12 (1946)

Hillier, J., Ellis, S. G., The Illuminating System of the Electron Microscope; J. Appl. Phys., 20:700 (1949)

Hillier, J., Gettner, M. E., Sectioning of Tissue for Electron Microscopy; Science, 112:520 (1950)

Hillier, J., Ramberg, E. G., The Magnetic Electron Microscope Objective: Contour Phenomena and the Attainment of High Resolving Power; J. Appl. Phys., 18:48 (1947)

Hock, C. W., An Electron-Microscopical Examination of Rayon; Textile Research J., 18:366 (1948)

Hock, C. W., Degradation of Cellulose as Revealed Microscopically Textile Research J., 20:141 (1950)

Hummel, D., Infra-Red Spectroscopic Identification of Rubber: Soft and Hard Vulcanized Rubber, Kautschuk u Gummi 11 WT 135-90 (1958)

Iwasaki, M., Aoki, M., Okuhara, K., The Infrared Spectma of Tetrafluoroethylene, Trifluorochloroethylene Copolymers; J. Polymer Sci., 26:116 (1951)

Kalmus, E. H., Preparation of Aerosols for Electron Microscopy; J. Appl. Phys., 25:87 (1954)

Kamagawa, H., et al (Tokyo Shibaura Elec.Co. Ltd. Kawasaki) Electron Microscope Investigation of Silicone Rubber, Proc. Intern. Conf. Electron Microscopy, 3rd, London 1954 507-11 (Pub. 1956)

Kaye, W., An Aluminum-Beryllium Alloy for Substrate and Replica Preparations in Electron Microscopy; J. Appl. Phys., 20:1209 (1949)

Kelsey, R. H., Hunson, E. E., A Method for Preparing Rubber Latex Specimens for the Electrons Microscope: J. Appl. Phys., 17:675 (1946)

Khlebnikova, L., And Setkina, O., Spectrographic Determination of the Mineral Components in Rubber, Sbornik, Nauch Trudov Leningrad, Inst. Technoi Mekh. i Optiki Mat. Mekh Khim, No. 24, 140-5 (1957)

Kinsinger, W. G., Hock, C. W., Electron Microscopical Studies of Natural Cellulose Fibers; Ind. Eng. Chem., 40:1711 (1948)

Kohler, T. R., Parrish, W., X-Ray Diffractometry of Radioactive Samples; Rev. Sci. Instr., 26:274 (1955)

Kratky, O., Sand, H., Small-Angle X-Ray Diffraction Investigations of Natural Rubber; Kolloid-Z., 172:18 (1960)

Kraus, Gerard, Silica-Reinforced Rubber; U.S. 2964,457 (dec. 13, 1960)

Kress, K. E., Mees, F. G., Stevens, Identification of Curing Agents in Rubber Products, Ultra-violet Absopptiometric Analysis of Selective Solvent Extracts; Anal. Chem., 27:528 (1955)

Kress, K. E., Spectrophotometric Analysis of Accelerator, Rubber Mixtures; Anal. Chem., 23:313 (1951)

Krimm, S., Stein R. S., An X-Ray Spectrometer for Polymer Studies; Rev. Sci. Instr., 22:920 (1951)

Kuzminskii, A.S., Nikitina, T. S., et al; Irradiation of Elastomers Before and After Vulcanization; Proc. Un.N. Intern. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva, 1958, 29:258 (1959)

Ladd, W. A., Electron Microscope Studies of Colloidal Carbon in Vulcanized Rubber; Ind. Eng. Chem., 16:642 (1944)

Ladd, W. A., The Electron Microscope and its Application to Rubber Testing and Research; Vandervilt Rubber Handbook, (1958)

Ladd, W. A., Braendle, H. A., High-Speed Microtome for Electron Micrscopy; Rubber Age., 57 (Sept, 1945)

Ladd, W. A., Hess, W. M., Ladd, M. W., High Resolution X-Ray Microscopy; Norelco Report, 2:83 (Sep, Oct, 1955)

Ladd, W. A., Ladd, M. W., Carbon Gel as Revealed by the Electron Microscope; Ind. Eng. Chem., 43:2564 (1951)

Ladd, W. A., Wiegand, W. B., Electron Microscope Studies of Colloidal Carbon Reticulate Chain Structure; Rub. Age, (June 1945)

Ladd, W. A., Wiegand, W. B., Electron Microscope Studies of Colloidal Carbon Reticulate Chain Structure; Rubber Age, 57 (Sept 1945)

Lang, A. R., Diffracted-Beam Monochromatization Technique in X-Ray Diffractometry; Rev. Sci. Instr., 27:17 (1956)

Lang, A. R., Rocusing Transmission Specimen Technique for the X-Ray Diffractometer; Rev. Sci. Instr., 26:630 (1955)

Laning, Stephen, H., Wagner, Melvin P., Sellers, John W., The Determination of Zinc Oxide in Rubber Vulcanizates by X-Ray Diffraction; J. Appl. Polymer Sci., 2:225 (1959)

Marrinan, H. J., Infrared Dichroism of a Stretched Polymer. I. The Theoretical Treatment of Rubberlike Polymers; J. Polymer Sci., 39:461 (1959))

Le Bras, J., Application Des Rayons x a. L Etude Des Substances Fortement Polymerisees. Cas Particulier Du Caoutchouc; Rev. Gen. Caoutchouc, 17:82 (1940)

Letner, H. R., Maloof, S. R., Stress Measurement by X-Ray Diffraction; J. Appl. Phys., 25:1440 (1954)

Liebhafsky, H. A., Analytical Methods Based Upon X-Ray Absorption; Anal. Chem., 25:639 (1953)

Liebhafsky, H. A., X-Ray Absorption: Anal. Chem., 21:17 (1949)

Liebhafsky, H. A., X-Ray Absorption: Anal. Chem., 22:15 (1950)

Liebhafsky, H. A., X-Ray Absorption; Anal. Chem., 23:14 (1951)

Liebhafsky, H. A., X-Ray Absorption; Anal. Chem., 24:16 (1952)

Liebhafsky, H. A., X-Ray Absorption & Emission; Anal. Chem., 26:26 (1954)

Liebhafsky, H. A., Winslow, E. H., X-Ray Absorption & Emission; Anal. Chem., 30:580 (1958)

Liebhafsky, H. A., Winslow, E. H., X-Ray Absorption & Emission; Anal. Chem., 28:583 (1956)

Liebhafsky, H. A., Zemany, P. D., Film Thickness by X-Ray Emission Spectrography; Anal. Chem., 28:455 (1956)

Liebhafsky, H. A., Smith, H. M., Tanis, H. E., Winslow, E. H., Chemical Analysis Based on X-Ray Absorption Measurements with a Multiplier Phototube; Solids and Liquids I: Gases II; Anal. Chem., 19:861 (1947)

Lining, J., and Stewart, J. (Natl. Bur. of Standards, Washington, D.C.) Infra-Red Studies of Some Structural Changes in Natural Rubber During Vulcanization, J. Reasearch Natl. Bur. of Standards 60 no.1, 9-21 (1958)

Lykin, A., and Pechkovskaya, K, Electron Microscopic Investigation of Vulcanized Natural and Synthetic Rubbers, Izvest. Akad. Nauk. SSSR.Ser. Fiz. 23, 725-8 (1958)

Mabis, A. J., Lindahl, R. H., X-Ray Beam Alignment Device; Rev. Sci. Instr., 27:328 (1956)

Mack, M., Bibliography of X-Ray Spectrochemical Analysis: Fluorescence & absorption; Norelco Report, 3:37

Madorsky, S. L., Straus, S., High Vacuum Pyrolytic Fractionation of Plystyrene; Ind. Eng. Chem., 40:848 (1948)

Martin, L., A 100-kv Electron Microscope; J. Appl. Phys., 16:131 (1945)

Marton, L., Electron Interference and Phase Effects; Proceedings of International Conference on Electron Microscopy held at London, (Jul. 1954)

Marton, L., Schiff, L. I., Determination of Object Thickness in Electron Microscopy; J. Appl. Phys., 12: 759 (1941)

Matthews, J. L., Peiser, H. W., Richards, R. R., The X-Ray Measurement of the Amorphous Content of Polythene Samples; Acta. Cryst., 2:85 (1949)

Maynard, J. T., Mochel, W. E., The Structure of Neoprene. VII. Infrared Analysis of configuration; A. Polymer Sci., 13:251 (1954)

Mellon, M. G., Light Absorption Spectrometry; Anal. Chem., 26:2 (1954)

Mellon, M. G., Bolts, D. F., Light Absorption Spectrometry; Review of Fundamental Developments in Analysis; Anal. Chem., 30:554 (1958)

Mellon, M. G., Boltz, D. F., Light Absorption Spectrometry: Review of Fundamental Developments in Analysis; Anal. Chem., 28:559 (1956)

Mochel, W. E., Hall, M. B., The Structure of Neoprene. IV. Infrared Spectra and Spectral changes with crystallization; J. Am. Chem. Soc., 71:4082 (1949)

Naata, G., Corradini, P., Crystal Structure of Cis-1, 4-Polybutadiene; Nuovo cimento, 15:111 (1960)

Nelson, K., and Roddubyyi, I., Infra-Red Absorption Spectra Investigation of the Polyisoprene Molecular Chain Structure, Proc. Acad. Sci. USSR Sect. Phys. Chem., 115:509 (1957)

Newton, C. J., Mandelkern, L., Roberts, D. E., Preferred Orientation in Stark Rubber Studied with an Automatic Integrating Pole Figure Goniometer; J. Appl. Phys., 26:1521 (1955)

Nichols, J. B., X-Ray & Infrared Studies on the Extent of Crystallization of Polymers: J. Appl. Phys., 25:840 (1954)

O'Brien, H. C., Jr., A. Vibrating Muller for the Preparation of Dispersions of Fine Pigments for Electron Microscopy; Science, 103:429 (1946)

O'Brien, H. C. Jr., Pigment Dispersion Methods for Electron Microscopy; J. Appl. Phys., 16:370 (1945)

O'Brien, H. C. Jr., Then Sections Methods for the Electron Microscopic Examination of Cured Polymer; No official pub.,

Ohlberg, S. M., Alexander, L. E., Warrick, E. L., Crystallinity & Orientation in Silicone Rubber. I. X-Ray Studies; J. Polymer Sci., 27:1 (1958)

Palen, V. (N. Am. Phillips Co., Mount Vernon, N.Y.) How to Apply X-Ray Analysis Techniques to Rubber Problems, Rubber Age, N.Y.;81:276 (1957)

Parrish, W., Engstrom, A., Modern X-Ray Chemical Analysis; Svensk Kem. Tidskr., 68:437 (1956)

Parrish, W., X-Ray Intensity Measurements with Counter Tubes; Phillips Tech. Rev., 17:206 (1956)

Parish, W., X-Ray Spectrochemical Analysis; Phillips Tech. Rev., 17:269 (1950)

Parrish, W., Kohler, T. R., A Comparison of X-Ray Wavelengths for Powder Diffractometry; J. Appl. Phys., 27:1215 (1956)

Parrish, W., Kohler, T. R., Use of Counter Tubes in X-Ray Analysis; Rev. Sci. Instr., 27:795

Piore, E. R., Kingston, R. H., Gyorgy, E. M. Harvey, G. G., The Soft X-Ray Spectroscopy of Solids; Rev. Sci. Instr., 22:543 (1951)

Pisarenko, A., and Shtarkh, B., The Microheterogeneity of Synthetic Rubbers, Kauchuk i Rezina 17; No. 5, 10 (1958)

Post, B., Fankuchen, I., X-Ray Diffraction; Anal. Chem., 28:591 (1956)

Preuss, L. E., Watson, J. H. L., A Technique for Takin Motion Pictures of Electron Microscope Images; J. Appl. Phys., 21:902 (1950)

Rady, A. (Ain Shams Univ. Cairo) Dynamic Properties of the New Rubberlike Irradiated Polyethylene, J. Appl. Polymer Sci. 1:129 (1959)

Rainc, H. C., Richards, R. B., Ryder, H., Heat of Solution and Heat Capacity Crystallinity of Polythene, Trans. Faraday Soc., (Feb. 1945)

Ramberg, E. G., Hillier, J., Chromatic Aberration and Resolving Power in Electron Microscopy; J. Appl. Phys., 19:678 (1948)

Reiney, M. J., Tryon, M., Achhammer, B. G., Study of Degradation of Polystyrene, Using Ultraviolet Spectrophotometry; J. Research Nat. Bur. Standards, 51:155 (Sept. 1953)

Reisner, J. H., Dornelf, E. G., A Small Electron Microscope; J. Appl. Phys., 21:113; (1950)

Reynolds, J. H., High Sensitivity Mass Spectrometer for Noble Gas Analysis; Rev. Sci. Instr., (1956) 27:928

Rippere, R. E., Preparation of Mulls of Rubbery Materials for Infrared Examination; Anal. Chem., 25:363 (1953)

Roberts, D. E., Mandelkern, L., Nature of Stark Rubber; J. Research Nat. Bur. Standards, 54:167 (Mar. 1955)

Robinson, Charles F., Nonuniform Fieldsin Cycloidal-Focusing Mass Spectrometers; Rev. Sci. Instr. 27:509 (1956)

Robinson, Charles F., Space Charge in Cycloidal-Focusing Mass Spectrometers; Rev. Sci. Instr. 27:512 (1956)

Robinson, Charles F., Hall, Lawrence G., Small General Purpose Cycloidal-Focusing Mass Spectrometer; Rev. Sci. Instr., 27:504 (1956)

Salomon, G., Infraroodspectroscopic; Chem. Weekbead, 53:581 (1957)

Salomon, G., van der schee, A. C., Infrared Analysis of Isomerized, Vulcanized and Oxidized Natural Rubber: J. Polymer Sci., 14:181 (1954)

Salomon, G., van der Schee, A. C., Ketelaar, J. A. A., van Eyk, B. J., Infra-Red Analysis of Rubber Derivative; Discussions Faraday Socl, No. 9: 291 (1950)

Salomon, G., van der Schee, A. C., Infrared Analysis of Some Chlorinatied Natural Rubbers; J. Polymer Sci., 14:287 (1954)

Schaeffer, Oliver A., An Improved Mass Spectrometer Ion Source; Rev. Sci. Instr. 25:660 (1954)

Seal, M., Direct Electron-Microscope Study of Thin Rubber Films; Intern. Kongr. Electronenmikroskopie, 4., Berlin, 1958, Verhandl, 1:746, (1960)

Seal, M., The Fine Structure of Films of Rubber and Other Polymers; Phil Mag., 5:78 (1960)

Sears, W. C., Infra-Red Spectra of Rubber and High Polymers; J. Appl. Phys. 12:35 (1954)

Setkins, O., and Ikhrimenko, I., Determination of Unsaturation of Cross-Linked Polymers of Rubber by Infra-Red Spectra, Turdy, Leningrad, Tekhnol. Inst. im. Lensoveta 37:91 (1957)

Setknia, Ol, and Uryan, R., Spectroscopic Analysis of Mineral Components in Rubber Compounds, Kauchuk i Rezina 18 3:10 (1959)

Shelberg, W., and Gevantman, L., (U.S. Naval Rediol. Defense Lab., San Fransisco, Calif.) X-Ray Diffraction Measurement of Radiation Damage in Stretched Rubber; Nature, 183:456 (1959)

Shelberg, W. E., Gevantman, L. H., X-Ray Diffraction Comparison of Radiation Damage in Rubbers; Rubber Age, 87:263 (1960)

Shenfil, L., Danielson, W. E., DuMond, J. W. M., A Point Focusing X-Ray Monochromator for the Study of Low Angle Diffraction; J. Appl. Phys. 23:854 (1952)

Shretsov, V. A., Pisarenko, A.P. et al, Electron-Microscope Investigation of Reinforced Rubber; Kolloid. Zhur., 22:233 (1960)

Simpson, J. A., Electron Interference Experiments; Rev. Modern Phys., 28:254 (1956)

Smith, C. S., Barrett, R. L, Apparatus & Techniques for Practical Chemical Identification by X-Ray Diffraction; J. Appl. Phys., 18:177 (1947)

Stanton, Henry, E., Chupka, William A., Inghram, Mark G., Electron Multipliers in Mass Spectrometry; Effect of Molecular Structure; Rev. Sci. Instr., 27:109 (1956)

Statton, W. O., Crystallite Regularity and Void Content in Cellulose Fibers as Shown by Small-Angle X-Ray Scattering; J. Polymer, 22:384 (1956)

Statton, W. O., Higher Orders of Long-Period X-Ray Diffraction in Polyethylene Fibers; J. Polymer Sci. 28:423 (Mar. 1958)

Statton, W. O, Godard, G. M., Tridirectional X-Ray Patterns of Oriented Film at Wide and Small Angles; J. Appl. Phys., 28:1111 (1957)

Stein, R. S., The X-Ray Diffractions, Birefringence, and Infrared Dichroism of Stretched Polyethylene, II. Generalized Uniaxial Crystal Orientation; J. Polymer Sci., 31:327 (1958)

Sterling, G., et al (Dow Chem Co., Midland, Mich.) Terpolymer Rubbers-Standardization of Infr-Red Analysis by Chemical and Radiotracer Methods, Anal. Chem. 31:1612 (1959)

Stevens, H. P., the Fine Structure of Rubber and Related Colloids; Comment on Electron Microscopic Studies of "Natural and Synthetic Rubber Fibers"; India Rubber J., 324 (Mar. 1945)

Stromberg, R. R., Straus, S., Achhammer, B. G., Infrared Spectra of Thermally Degraded Poly (Vinyl Chloride); J. Res.Nat. Bureau Stds., 60:147 (1958)

Swerdlow, M., Dalton, A. J., Birks, L. S., Electron Microscopy; Anal. Chem., 28:597 (1956)

Tanaka, T., et al (Kyushu Univ., Fukuoka City) Analysis of Natural and Synthetic Rubber by Infra-Red Spectroscopy, Nippon Gomu Kyokaishi, 30:762 (1957)

Taylor, J., Parrish, W., Absorption and Counting-Efficiency Data for X-Ray Detectors; *Rev. Sci. Instr.*, 26:367 (1955)

Tobolsky, A. V., Kelley, D. D., O'Driscoll, K. F., Rogers, C. E., Directed Anionic Polymerization; *J. Polymer Sci.*, 28:425 (1958)

Wall, Leo. A., Mass Spectrometric Investigation of the Thermal Decomposition of Polymers; *J. Research Nat. Bur. Standards*, 41:315 (1948)

Warren, B. E., The Absaption Displacement in X-Ray Diffraction by Cylindrical Samples; *J. Appl. Phys.*, 16:614 (1955)

Warren, B. E., X-Ray Diffractions Methods; *J. Appl. Phys.* 12:375 (1941)

Watson, J. H. L., Electron Microscopy of RadiationPolymerization Products; *J. Phy. & Co. Chem.*, 52:470 (1948)

Watson, J. H. L., The Morphology of Carbon Black Particles in Shadow-Cast Specimens; *J. Appl. Phys.*, 20:747 (1949)

Watson, J. H. L., Grube, W. L., The Reliability of Internal Standards for Calibrating Electron Microscopies; *J. Appl. Phys.*, 23:792 (1952)

Wiegand, W. B., Further Electron Microscope Studies on Colloidal Carbon and The Rose of Surface in Rubber Reinforcement; *Can. Chem. Process Ind.*, (Nov. 1941)

Wiegand, W. B., Ladd, W. A., Colloidal Carbon as Revealed by the Electron Microscope; *Rubber Age*, (Mar. 1942)

Williams, E., Dale, B., Further Studies of the Infra-Red Absorption of Rubber; *J. Appl. Phys.*, 15:585 (1944)

Yokohama, T., et al,(Ind. Res. Inst. Hyogo Prefacture, Kobe) X-Ray Diffraction Studies of Rubber Compounding Powder Systems III. Preferred Orientation of Nonspherical Particles in Rubber Sheets, *Nippon Gomu Kyokaishi*, 31:87 (1958)

Zemany, P. D., Winslow, E. H., Poellmitz, G. S., Liebhafsky, H. A., X-Ray Abosption Measurements; Comparative Method for Chemical Analysis Based on Measurements with Multiplier Phototube; *Anal. Chem.*, 21:493 (1949)

Zyorykin, V. K., Ramberg, E. G., Applications De La Microscopic Electronique Et. De La Diffraction Electronique A La Metallurgic; Centenaire de l'A. I. Lg. Congres 1947, Section Metallurgic Physique.

Zyorykin, V. K., Ramberg, E. G., Surface Studies with the Electron Microscope; *J. Appl. Phys.*, 12:692 (1941)

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THERMODYNAMICS

BIBLIOGRAPHY

Abashina, R.F., Gridunova, E.B., Lysenko, A.V., Effect of Addition of Synthetic Resins on Physicomechanical Property of Hard Rubber; Trudy Nauch.-Issledovatel. Inst. Rezin: Prom., :52 (1960)

Adams, H.E., Johnson, B.L., Cross Linking in Natural Rubber Vulcanizates; Ind. Engr. Chem., 45, 1539 (1953)

Aitken, A., Barrer, R.L., Transport and Solubility of Isomeric Paraffins in Rubber; Trans. Faraday Soc., 51:116 (1955)

Alekseenko, V.I., Mishustin, I.V., The Compatibility of Ternary Polymer Systems, Zhur. Fiz. Khim., 33, 757-63 (1959)

Allen, Geoffroy, Gee, Geoffrey, Read, B.E., Stress Relaxation in Elastomers by Viscoelastic Mechanisms. I. Natural Rubber at High Rates of Strain and Low Temperatures; Trans. Faraday Soc., 55:1651 (1959)

Allen, P.W., (Brit. Rubber Producers Research Assoc., Wolwyn Garden City, Engl.), The Swelling Behavior of Natural Rubber Lakes; J. Colloid Sci. 13, 483-7 (1958)

Altgelt, K., Schulz, G.V., (Univ. Mainz, Ger.): Determination of the Molecular Constants of Natural Rubber. II. Intrinsic Viscosity (Staudinger-Index) Semimentation and Diffusion Constants in Cyclohexane; Makromol Chem., 32, 66-78 (1959)

Altgelt, K., Schulz, G.V., Determination of Molecular Constants of Natural Rubber. III. Molecular Weight, Gyration Radius, and Thermodynamic Properties of Cyclohexane -Rubber Solutions by the Light-Scattering Methid; Makromol. Chem., 36:209 (1960)

American Society for Testing Materials. Symposium on Recent Developments in the Evaluation of Natural Rubber; ASTM Special Technical Pub. No. 136 (1953)

Ameronger, C.J. Von, Koningsberger, C., Salomon, G., Chlorination of Natmral Rubber. I. Preparation and Properties of Chlorinated Rubber; J. Polymer Sci., 5:639 (1950)

Ameronger, C.J. Von, Koningsberger, C., Salomon, G., Chlorination of Natural Rubber. II. Preparation and Properties of Rubber Dichlorides; J. Polymer Sci., 5:653 (1950)

Ameronger, C.J., Der Einfluss von Fullstoffer Anf Die Gasdurchlansigkeit von Kantschuer; Kautschuk N. Gummi: 7:132 (1954)

Arlman, E.J., Melville, H.W., Studies in Copolymeriation: The Evaluation of the Kinetic Coefficients for the System Styrene-Butyl Acrylate; Proc. Roy. Soc., 203:30; (1950)

Arlman, E.J., Melville, H.W., Valentine, L., The Copolymerisation of Sytrene and Methyl Methacrylate, Styrene and Butyl Acrylate; Rec. Trav. Chem., 68:945 (1949)

Arnold, A., Madorsky, I., Wood, L.A., Measurement of Refractive Index of Elastomers; Anal. Chem., 23:1656 (1951)

Avivi, P., Weinreb, A., Transfer of Energy of Solid Plastic Solutions; J. Chem. Phys., 27:716 (1957)

Badische Anilin & Soda -Fabril Akt.-Ges., Polymers with High Impact Strength; Ger. 1,019,465 (Nov. 14, 1957)

Bakes, W.O., Fuller, C.S., Intermolecules Forces and Chain Configuration in Lines Polymers - The Effect of N-Methyestion on the X-Ray Structures and Properties of Linear Polyamides; J. Am. Chem. Soc., 65:1120 (1953)

Baker, L.C.W., Anderson. T.F., Some phase Relationships in the Three-Component Liquid System CO_2-H_2O-C_2H_5OH at High Pressures; J. Am. Chem. Soc., 79:2071 (1957)

Baker, W.O., Crystallinity in Cellulose Esters; Sci. Monthly 55:435 (1942)

Baker, W.O., Interchain Order and Orientation in Cellulose Esters; Ind. Eng. Chem., 37:246 (1945)

Baker, W.O., Yager, W.A., The Relation of Dielectric Properties to Structure of Crystalline Polymers, I&II; J. Am. Chem. Soc., 64:2164 (1942)

Baker, W.O., Fuller, C.S.,Thermal Evidence of Crystallinity in Linear Polymers; Ind. Eng. Chem., 38:272 (1946)

Bardwell, J., Winkler, C.A., Network Formation, II. Can J. Research, B27, 128 (1949)

Bardwell, J. Winkler, C.A., Statistics of Network Polymers, I., Can. J. Research, B27, 116 (1949)

Bardwell, J., Winkler, C.A., The Effect of Network Structure on Elastic Properties, III., Can. J. Research, B27, 139 (1949)

Barrer, R.M., Some Properties of Diffusion Coefficients in Polymers; J. Phys. Chem., 61:178 (1947)

Barrer, R.M., Fergusson, R.R., Diffusion of Benzene in Rubber and Polythene; Trans. Faraday Soc., 54:989 (1958)

Barrer, R.M., Skirrow, G., Transport and Equilibrium Phenomena in Gas-Elastomer Systems, I. Kinetic Phenomena; J. Polymer Sci., 3:549 (1948)

Bartenev, G.M., Novikova, N.M., (Sci. Research Inst. Rubber, Ind., Moscow), Deformation of Rubber on Percussion, Kolloid Zhur., 21, 3 (1959)

Bauman, Richard G., Radiation Damage to Elastomers. II. Cross-Linking and Antirad Action; J. Appl. Polymer Sci., 2:328 (1959)

Bawn, C.E.H., and others, High Polymer Solutions. I., Vapor Pressures of Polystyrene Solutions, Trans. Faraday Soc., 46:677 (1950)

Baxendale, J.H., Bywater, S., Evans, M.G., Molecular Weight Distributions in Polymethyl Methacrylates; Trans. Faraday Soc., 42:675 (1946)

Baxendale, J.H., Evans, M.G., Park, G.S., The Mechanism and Kinetics of the Initiation of Polymerisation by Systems Containing Hydrogen Peroxide; Trans. Faraday Soc., 42:155 (1946)

Baxendale, J.H., Evans, M.G., Velocity Constants of the Propagation and Termination Steps in Polymerisation Reactions; Trans. Faraday Soc., 43:1 (1947)

Baxter, S., Potts, P.D., Vodden. H.A., Stress Relaxation in Rubber Simultaneous Oxygen Absorption, Ind. Eng. Chem., 47:1481 (1955)

Bearman, R.J., The Thermo-Osmosis of the Rare Gases Through a Rubber Membrane; J. Phys. Chem., 61:708 (1947)

Bedin, A.A., Kronman, A.G., et al, Impact -Stable Poly(vinyl choride); Plasticheskie Massy, :2 (1960)

Berlin, A.A., Kronman, A.G., et al, Impact -Stable Poly(vinyl choride); Plasticheskie Massy, :2 (1960)

Berry, J.P., Scanlan, J., Watson, W.F., Cross-Link Formation in Stretched Rubber Networks; Trans. Faraday Soc., 52:2 (1956)

Bestul, A.B., Kinetics of Capillary Shear Degradation in Concentrated Polymer Solutions; J. Chem. Phys., 24:1196 (1956)

Bibliography of Rubber Literature for 1952-54, H.E. Lerner, ed., Wash., D.C.; Division of Rubber Chemistry, Amer. Chem. Soc. :793 (1959)

Blackley, D.C., Melville, H.W., Valentine, F.R.S., Valentine, L., Rates of Polymerization in the System Styrene, p-Methoxystyrene, and Methyl Methacrylate; Proc. Roy. Soc. 227:10 (1954)

Blanchard, A.F., Breakage of Rubber-Filler Linkages and Energy Dissipation in Stressed Rubber; J. Polymer Sci. 14:355 (1954)

Blanchard, A.F., Theory of the Stress-Strain Characteristics of Reinforced Rubber; Trans. Inst. Rubber Ind., 32:124 (1956)

Boggs, F.W., Statistical Mechanics of Rubber; J. Chem. Phys., 20:632 (1952)

Bolland, J.L., Kinetic Studies of the Chemistry of Rubber and Related Materials; VIII. Influence of Chemical Structure on the Methylenic Reactivity of Olefins; Trans. Faraday Soc., 46:358 (1950)

Bolland, J.L., Kinetic Studies in the Chemistry of Rubber and Related Materials: VI. The Benzoyl Peroxide-Catalysed Oxidation of Ethyl Linoleate; Trans. Faraday Soc., 44:669 (1948)

Bolland, J.L., Have, P.T., Kinetic Studies in the Chemistry of Rubber and Related Materials: IV. The Inhibitory Effect of Hydroquinone on the Thermal Oxidation of Ethyl Linoleate; Trans. Faraday Soc., 42:201 (1947)

Bolland, J.L., Have, P.T., Kinetic Studies in the Chemistry of Rubber and Related Materials: VII. The Mechanism of Chain Propagation in the Oxidation of Polyisoprenes; Trans. Faraday Soc., 45:93 (1949)

Bonsall, E.P., Valentine, L., Melville, H.W., Studies in Copolymerization Kinetics of the Copolymerization of Styrene and p-Methoxystyrene; J. Polymer Sci. 7:39 (1951)

Borovitskaya, N.M., Dependence of Dynamic Properties of Rubber on Deformation Amplitude; Zhur. Tekh. Fiz., 28:2689 (1958)

Boyer, R.F., Effect of Plasticizers on Some Physical Properties of Polymers; Tappi, 34:357 (1951)

Boyer, R.F., Relationship of First-To-Second-Order Transition Temperatures for Crystalline High Polymers; J. Appl. Phys., 25:825 (1954)

Boyer, R.F., Spencer, R.S., Thermal Expansion and Second-Order Transition Effects in High Polymers: II. Theory; J. Appl. Phys., 16:594 (1945)

Brandt, W., Calculation of Compressibilities of High Polymers from the Energy of Interaction Between Chain Groups; J. Chem. Phys., 26:262 (1957)

Brandt, W., Theory of Molecular Chain Crystals and Its Application to High Polymers; Ind. Eng. Chem., 50:1022 (1958)

Bristow, G.M., Watson, W.F., (Brit. Rubber Producers Research Assocn., Welwyn Garden City, Engl.), Cohesive Engergy Densities of Polymers: I., Cohesive Energy Densities of Rubbers by Swelling Measurements, Trans. Faraday Soc., 54, 1731, (1958)

Bristow, G.M., Watson, W.F., Swelling in Pure Solvents; Trans. Faraday Soc., 54, 1567 (1958)

Bristow, G.M., Watson, W.F., Swelling in Pure Solvents; Trans. Faraday Soc., 54, 1731, 1742 (1958)

Bristow, G.M., Swelling of Rubber Networks in Binary Solvent Mixtures; Trans. Faraday Soc., 055, 1246-53 (1959)

Bristow, G.M., Watson, W.F., (Brit. Rubber Producers Research Assocn., Welwyn Garden City, Engl.), Swelling and Viscosity of Rubbers in Mixed Solvents, Trans. Inst. Rubber Ind., 35, 73 (1959)

Bristow, G.M., Watson, W.F., (Brit. Rubber Producers Research Assocn., Welwyn Garden City, Engl.), Viscosity Equil. Swelling Correlations for Natural Rubber, Trans. Faraday Soc., 54, 1567 (1958)

Bronsted, J.N., Volguartz, K., Solubility and Swelling of High Polymers; Trans. Faraday Soc., 35:576 (1939)

Brown, D.W., Wall, L.A., Pyrolysis of Poly-a-Methylstryrene; J. Phys. Chem., 62:848 (1958)

Bueche, A.M., An Investigation of the Theory of Rubber Elasticity Using Irradiated Polydimethylsiloxanes; J. Polymer Sci., 19:297 (1956)

Bueche, A.M., Interaction of Polydimethyesiloxanes with Swelling Agents; J. Polymer Sci., 155:97 (1955)

Bueche, F., (Univ. of Wyoming, Laramie), Dynamics of Lossely Cross-Linked Polymer Networks, J. Appl. Polymer Sci., 1:240 (1959)

Bueche, F., (Univ. of Wyoming, Laramie), Non-Newtonian Viscosity of Synthetic Rubber and its Solutions, J. Appl. Phys., 30:1114 (1959)

Bueche, F., (Univ. of Wyoming, Laramie), Tensile Strength of Filled GR-S Vulcanizates, J. Polymer Sci., 33:259 (1958)

Bunn, C.W., Special Issue on High Polymer Physics: Molecular Structure and Crystallinity of Long-Chain Polymers; J. Appl. Phys., 25:820 (1954)

Burnett, G.M., Evans, P., Melville, H.W., Polymerization of Esters of Methcrylic Acid: I. The Polymerization of N-Butyl Methacrylate; Trans. Faraday Soc., 49:1096 (1953)

Burnett, G.M., Evans, P., Melville, H.W., Polymerization of Esters of Methacrylic Acid: II. The Polymerization of N-Propyl Methancrylate; Trans. Faraday Soc., 49:1105 (1953)

Bufte, H., Halsey, G., Dillon, J.H., A New Concept of the Mechanical Behavior of Fibers; Textile Research J., 18:449 (1948)

Carmen, F.H., Powers, P.O., Robinson, H.A., Swelling of Synthetic Rubbers in Mineral Oil. Effect of Variation in Aniline Point of Oils; Ind. Eng. Chem., 32:1069 (1940)

Carpenter, A.S., Crystallinity in Solid Colloids: II. Solution &Diffusion in High Polymers; Trans. Faraday Soc., 43:529 (1947)

Cass, L.C., Elastomer Behavior: II. Uniaxial Stress-Strain Relations; Makromol. Chem., 39:119 (1960)

Catton, N.L., Edwards, R.C., Loring, T.M., A Practical Method of Classifying all Elastomeric Vulcanizates; ASTM Bull. 243:69-73 (1960)

Charch, W.H., Shivers, J.C., Structure-Property Relationships in Synthetic Fibers: II. Elastomeric Condensation Block Copolymers; Textile Research J., 29:536 (1959)

Charch, W.H., Mosely, W.W. Jr., Structure-Property Relationships in Synthetic Fibers: I. Structure as Revealed By Sonic Observation; Textile Research J., 29:525 (1959)

Charlesby, A., Bon Arnim. E., Cross-Linking of Oriented Rubber; J. Polymer Sci., 25:151 (1957)

Ch'ien, Jen-Yuan, Teng, Li-Ju, Shear Rate Dependence of the Viscosities of SBR in Toluene; Sci. Sinica, 9:421 (1960)

Chien, Pao-Kung, et al, Viscoelastic Properties of Native Hevea Rubber: II. Effect of Crystallinity on the Type of Flow; Tung Pei Jen Min Ta Hsueh-Tsu Jan Ko Hsueh Pao, 1957, No 2, 115-25

Clews, C.J.B., Schallamach, A., Structure of Isoprene; Nature, 157:160 (1946)

Clews, C.J.B., Schosaberger, G., Structure of Stretched Rubber; Proc. Roy. Soc., 164:401 (1938)

Clews, C.J.B., The Structure of Polychloroprene; Proc. Roy. Soc., 180:100 (1942)

Conant, F.S., Hall, G.L., Thurman, G.R., Relationship Between Gough-Joule Coefficients and Module of Vulcanized Rubbers; J. Appl. Phys., 20:526 (1949)

Connecticut Hard Rubber Co., Heat- Resistant, High-Tensile Silicone Rubber Compounds; Brit. 826:322 (Jan. 6, 1960)

Conway, B.E., Lakhanpal, M.L., Polyoxypropylene Glycols: II. Derived Thermodynamic Functions for the Systems: Polyglycols-Methanol; J. Polymer Sci., 46:93 (1960)

Conway, B.E., Tong, S.C., Polyoxypropylene Glycols: III. Equilibrium Swelling of Cross-Linked Polyurethan Elastomers; J. Polymer Sci., 46:113 (1960)

Crank, J., Park, G.S., Diffusion in High Polymers: Some Anomlies and Their Significance; Trans. Faraday Soc., 47:1072 (1951)

Crespi, G., Bruzzone, M., Cross-Link Density and Physical Properties of Ethylene-Propylene Copolymer Elastomers; Chim. e Ind. (Milan), 41:741-8 (1959)

Dean, M.R., Legatski, T.W., Specific Gravity of Butadiene; Ind. Eng. Chem., 16:7 (1944)

Degteva, T.G., Belitskaya, R.M., Kuz'munskit, A.S., Physical Chemical Foundation of the Process of Oxidative Degredation of Swollen Vulcanized Rubber: I. The Concurrent Oxidation of Rubber and Solvent in Swollen Vulcanized Rubber; Trudy Nauch-Issled-Ovatel Inst. Rezin. Prom., 1956, No 3, 73-85

Degteva, T.G., Kuz'munskit, A.S., Physical Chemical Foundation of the Process of Oxidative Degredation of Swollen Vulcanized Rubber: II. The Effects of Inhibitor on the Oxidative Degredation of Swollen Vulcanized Rubber; Trudy Nauch-Issledovatel. Inst. Rezin. Prom., 1956, No. 3, 86-101

Dermody, W.J., Modulus of Elasticity of Ebonite Materials: I. Tensile Measurements on SBR Vulcanizates; Rubber World, 142:79 (1960)

Deutsche Shell AKt.-Ges. and Metallgesellschaft AKt.-Ges., Rubber Mixtures with Improved Physical Properties; Ger. 1,077,865 (Mar. 17, 1960)

Devirts, E. Ya., Novikov, A.S., Properties of Soft Butadiene-Nitrile Rubber SKN-40, Which does not Require Mastication; Trudy Nauch-Issledovatel. Inst. Rezin. Prom., :17 (1960)

Dewey, J.M., The Elastic Constants of Materials Loaded With Non-Rigid Fillers; J. Appl. Phys., 18:578 (1947)

Dewey, J.M., Theory of Filler Reinforcement; J. Appl. Phys., 16: (Jan. 1945)

Dingle, A.D., Dynamic Mechanical Properties of Some New Elastomers; Rubber World, 143:93 (1960)

Dogadkin, B.A., et al, (Sci. Research Inst. Tire Ind., Moscow), Structure and Properties of Rubbers Obtained in Radiation Vulcanization; Kolloid Zhur. 20, 260 (1958)

Dogadkin, B.A.,(Inst. Rubber Ind., Moscow), Vulcanizate Structures and Their Changes During Vulcanization; Hot Stress Relaxation and Fatigue; Kautschuk u Gummi. 12, WT 5 (1959)

Doty, P., Brownstein, M., Schlener, W., Some Thermodynamic Properties of Polystyrene Solutions; J. Phys. & Colloid Chem., 53:213 (1949)

Dunell, B.A., Dillon, J.H., The Measurement of Dynamic Modulus and Energy Losses in Single Textile Filaments Subject to Forced Longitudinal Vibrations; Textile Research J., 21:393 (1951)

Dunn, J.R., (Brit. Rubber Producers Research Assoc. Welwyn Garden City, Engl.), Stress Relaxation During the Photo Oxidation of Peroxide Cross-linked Rubber; Trans. Faraday Soc., 54:730 (1958)

Dunn, J.R., et al, Stress Relaxation During the Thermal Oxidation of Vulcanized Natural Rubber; Trans. Faraday Soc., 55:667 (1959)

Dunning, W.J., Kinetics of Crystallization of Rubber; Trans. Faraday Soc., 50:1115 (1954)

Edwards, D.C., A Simple Direct Method for Measuring the Permeability of Rubber Vulcanizates to Gases; Rubber Age, (1956)

Farbenfabriken Bayer AKt.-Ges., Synthetic Rubber Having Improved Slip Resistance; Ger. 1,040,797 (Oct. 9, 1958)

Faull, J.H. Jr., European Elastomers Research: I. British Military Establishments; Office of Naval Research, (London); Technical Report ONRL-46-60 (Aug., 1960)

Fisher, M.P., Chain Configurations of Polymers and Polyelectrolytes; J. Chem. Phys., 28:756 (1958)

Fisher, M.E., The Excluded Volume Problem; Discussions Faraday Soc., 25:200 (1958)

Fletcher, W.P., Gent, A.N., Dynamic Shear Properties of Some Rubber-like Materials; Brit. J. Appl. Phys. 8:194 (1957)

Flint, C. Falconer, Use of Factice in Butyl Rubber: III. Effect on Special Properties of Butyl Rubber; Rubber J. and Intern. Pvastics, 139:490 (1960)

Flory, P.J., Constitution of Three-Dimensional Polymers and the Theory of Celation; J. Phys. Chem., 46:132 (1942)

Flory, P.J., Rabjohn, N., Shaffer, M.C., Dependence of Elastic Properties of Vulcanized Rubber on the Degree of Cross Linking; J. Polymer Sci., 4:225 (1949)

Flory, P.J., Rabjohn, N., Shaffer, M.C., Dependence of Tensile Strength of Vulcanized Rubber on Degree of Cross-linking; J. Polymer Sci., 4:435 (1949)

Flory, P.J., Rehner, J. Jr., Effect of Deformation on the Swelling Capacity of Rubber; J. Chem. Phys., 12:412 (1944)

Flory, P.J., Effects of Molecular Structure on Physical Properties of Butyl Rubber; Ind. Eng. Chem., 38:417 (1946)

Flory, P.J. Rehner, J., Statistical Mechanics of Cross-Linked Polymer Networks: I. Rubberlike Elasticity; J. Chem. Phys., 11:512 (1943)

Flory, Paul J., Rehner, John Jr., Statistical Mechanics of Cross-Linked Polymer Networks: II. Swelling; J. Chem. Phys., 11:521 (1943)

Flory, P.J., Swelling of Rubber Networks in Binary Solvent Mixtures; J. Chem. Phys., 9:660 (1941)

Flory, P.J., Krigbaum, W.R., Thermodynamics of High Polymer Solutions; An. Rev. Phys. Chem., 2:383 (1951)

Flory, P.J., Swelling of Rubber Networks in Binary Solvent Mixtures; J. Chem. Phys., 18:108 (1950)

Flory, P.J., Schultz, Swelling of Rubber Networks in Binary Solvent Mixtures: Theory of Swelling in Solvent Mixtures; J. Polymer Sci., 15:231 (1955)

Flory, P.J., Swelling Theory: Calculation of Mc.; Ind. Eng. Chem., 38:417 (1946)

Fox, T.G. Jr., Flory, P.J., Marshall, R.E., Thermodynamics of Crystallization in High Polymers: VI. Incipient Crystallization in Stretched Vulcanized Rubber; J. Chem. Phys., 17:704 (1949)

Frisch, H.L., Polymer Chain Configuration Near a Boundary Exerting Forces; J. Phys. Chem., 59:633 (1955)

Frisch, H.L., Simha, R., Statistical Mechanics of Flexible High Polymers at Surfaces; J. Chem. Phys., 27:702 (1957)

Frith, E.M., The Effect of Solvent Type on the Viscosity of Very Dilute Solutions of Long Chain Polymers; Trans. Faraday Soc., 41:17 (1945)

Fromandi, G., Ecker, R., Heideman, W., Stress-Strain Behavior of Elastomers at Different Speeds of Deformation; Kautschuk u. Gummi, 13:WT25 (1960)

Gavoret, G., Magat, M., Contribution to the Thermodynamics of High Polymer Solutions: V. Solubility of Heterogenous Polymers ; J. Chem. Phys., 17:999 (1949)

Gee, G., Equilibrium Properties of High Polymer Solutions and Gels; J. Chem. Soc., :280 (1947)

Gee, G., Allen, G., Read, B.E. (Univ. Manchester, Engl.), Stress Relaxation in Elastomers by Viscoelastic Mechanisms: I. Natural Rubber at High Rates of Strain and Low Temp.; Trans. Faraday Soc., 55:1651 (1959)

Gee, G., Orr, W.J.C., The Interaction Between Rubbers and Liquids: VIII. A New Examination of the Thermodynamic Properties of the System Rubber + Benzene; Trans. Faraday Soc., 42:2:507 (1946)

Gee, G., Treloar, L.R.G., The Interaction Between Rubber and Liquids: I. A Thermodynamical Study of the System Rubber-Benzene; Trans. Faraday Soc., 38:147 (1942)

Gee, G., The Interaction Between Rubber and Liquids: X. Some New Experimental Tests of a Statistical Thermodynamic Theory of Rubber-Liquid Systems; Trans. Faraday Soc., 42:33 (1946)

Gee, G., The Interaction Between Rubber and Liquids: IX. The Elastic Behaviour of Dry and Swollen Rubbers; Trans. Faraday Soc., 42:585 (1946)

Gee, G., The Interaction Between Rubber and Liquids: II. The Thermodynamical Basis of the Swelling and Solution of Rubber; Trans. Faraday Soc., 38:276 (1942)

Gehman, S.D., Relationship Between Molecular Structure and Physical Properties; Ind. Eng. Chem., 44:730 (1952)

General Electric Co., Organopolysiloxane Elastomer; Brit. 847,556 (Sept. 7, 1960)

Gent, A.N., Thomas, A.G. (Brit. Rubber Producers Research Assoc., Welwyn Garden City, Engl.), Deformation of Foamed Elastic Materials; J. Appl. Polymer Sci., 1:107 (1959)

Gessler, A.M., Effect of Attrited Blacks on Butyl-Rubber Properties; Rubber Age, 87:64 (1960)

Grisdale, R.O., Pfister, A.C., van Roosbroeck, W., Pyrolytic Film Resistors: Carbon and Borocarbon; Bell System Tech. J., 30:271 (1951)

Haim, E., Thermodynamic of the Elasticity of Rubber in the Light of The Work of G.M. Bartenev; Ind. Uscara (Bucharest) 3:321 (1956)

Ham, J.S., Viscoelastic Theory of Branched and Cross-Linked Polymers; J. Chem. Phys., 26:625 (1957)

Harper, R.M., The Effect of Di-Ester Lubricants on Aircraft Rubber Parts;; Rubber Age, (June, 1953)

Hartley, C.S., Diffusion and Swelling of High Polymers: III. Anisotropic Swelling in Oriented Polymer Film; Trans, Faraday Soc., 45:820 (1949)

Hartley, C.S., Diffusion and Swelling of High Polymers: I. The Swelling and Solution of a High Polymer Solid Considered as a Diffusion Process; Trans. Faraday Soc., 42B:6 (1946)

Hauser, R.L., Walker, C.A., Kilbourne, F.L. Jr., Swelling of Silicone Elasotmers; Ind. Eng.Chem., 48:1202 (1956)

Hayden, P., Estimation of Chain Fracture and Cross-Linking of Rubber by High Energy Radiation; Nature, 184:1865 (1959)

Hayes, R., (Firestone Tire and Rubber Co., Akron, Ohio), High Temperature Tensile Properties of Elastomers Containing Carboxyl Groups; J. Chem. Eng. Data 5, 1:63-5 (1960)

Hayes, H.J., Parks, G.S., The Diffusions of Benzene in Rubber: II. High Concentrations of Benzene; Trans. Faraday Soc., 52:949 (1956)

Hermans, J.J., Deformation and Swelling of Polymer Networks Containing Comparatively Long Chains: I. The Configurational Entropy of the Network; Trans. Faraday Soc., 43:591 (1947)

Hofman-Bang, H., Pedersen, H.L., The Acceleration Capacity of Organic Polythionates and Polysulphides; Acta. Chem. Scand., 12:861 (1958)

Houwink, R., Le Renforcement des Caoutchouc; Rev. Gen. Caoutchouc, 29:346 (1952)

Houwink, R., Ueber die Struktur des Kautschuks; Kolloid Z., 95:303 (1941)

Hsiao, C.C., Sauer, J.A., Effect of Strain Rate on the Tensile and Compressive Stress-Strain Properties of Polystyrene; ASTM Bulletin, No. 172 (Feb., 1951)

Huggins, M.L., A New Approach to the Theory of Rubberlike Elasticity; J. Polymer Research 1:1 (1946)

Huggins, M.L., Properties of Rubber Solutions and Gels; Ind. Eng. Chem., 35:216 (1943)

Huggins, M.L., Swelling of Rubber Networks in Binary Solvent Mixtures: Flory-Huggins Theory;; J. Chem. Phys., 9:440 (1941)

Introduction to Rubber Technology, Maurice Morton, ed., New York; Reinhold Pub. Corp. (1959)

James, H.M., Network Theory of Rubber Elasticity; Record Chem. Progr., Fall Issue:173 (1949)

James, H.M., Statistical Properties of Networks of Flexible Chains; J. Chem. Phys., 15:651 (1947)

James, H.M., Guth, E., Theory of the Elasticity of Rubber; J. Appl. Phys., 15:294 (1944)

James, H.M., Guth, E., Theory of the Increase in Rigidity of Rubber During Cure; J. Chem. Phys., 15:669 (1947)

Kainradl, P., Handler, F. (Semperit, Osterr.-Amerikanische Gummiwerke A.-G. Traiskirchen, Austria), Measurement of the Dynamic Properties of Vulcanizates; Kautschuk u Gummi 11 WT 193-9, WT 222-6, WT 226, WT229 (1958)

Kasuya, Taneichi, Hirata, Yoshiaki, Mixture of Natural Rubber — Butadiene-Styrene Rubber: I. Relation Between Ratio of Mixture and Physical Properties; Nippon Gomu Kyokaishi, 33:169 (1960)

Kase, S., (Togawa Rubber Co., Osaka), The Method of Adjusting Tensile Data of Vulcanizates VIII; Nippon Gomu Kyokaishi 30:852 (1957)

Kate, M., Tensile Strength of High Polymers; Rev. Gen. Caoutchouc, 35:777 (1958)

Kemmnitz, G., (Glanzstoff-Court., G. m. b. H., Kohn-Weidenpesch, Ger.), Investigation of Compression Fatigue and Damping Phenomena for Tire Cords; Kautschuk u. Gummi 12 WT 270-WT 282 (1959)

Kempermann, Th., Clamroth, R. (Farbenfabriken Bayer Akt. Ges., Leverkusen, Ger.), Determination of Relative Damping in the Presence of Different Pre-Stresses; Kautschuk u. Gummi 12 WT 96, WT 100, WT 102, WT 104, WT 106 (1959)

Kirkwood, J.G., Elastic Loss and Relaxation Times in Cross-Linked Polymers; J. Chem. Phys., 14:51 (1946)

Koningsberger, C., Salomon, G., Preparation and Properties of Rubber like High Polymers: I. Polymerization of Dienes and Vinyl Compounds in Bulk; J. Polymer Sci., 1:200 (1946)

Koningsberger, C., Salomon, G., Preparation and Properties of Rubber like High Polymers: II. Polymerization of Mixture in Bulk; J. Polymer Sci., 1:353 (1946)

Korol, I.P., Viscous Flow of Rubber: IV. Dependence of the Flow of Natural Rubber and Polyisobutylene on Molecular-Weight Composition; Zhur. Tekh. Fiz., 29:647 (1959)

Koshelev, F.F., Kung, Ko-Cheng, Kornev, A.E., Effect of Mercaptobenzothiazole (MBT) Salts and of Metal Oxides on the properties of Natural-Rubber Vulcanizates; Kauchuk i Rezina, 19:3 (1960)

Kostina, S., An Accelerated Method for the Determination of Swelling of Synthetic Rubber Vulcanizates; Kauchuk i Rezina 16, 12:30 (1957)

Kraus, Gerand, Degree of Cure in Filler-Reinforced Vulcanizates by the Swelling Method; Rubber World, 135:67 (1956)

Kraus, G., Short, J.M., Thornton, V., Effect of Cis-Trans Ratio on the Physical Properties of 1,4-Polybutadienes; Rubber & Plastics Age, (Oct., 1957)

Kress, K.E., Determination of Polyisobutylene in Rubber Products; Anal. Chem., 30:287 (1958)

Kress, K.E., Determination of Sulfur by Versatile Ultraviolet Absorptiometric Method; Beckman Technical Data DU-68-C(T) (May, 1957)

Kress, K.E., Photmetric Determination of Zinc Oxide in Rubber Products Absorptiometric and Trubidimetric Methods Using Sodium Diethyl Dithiocarbomate; Anal. Chem., 30:432 (1958)

Krigbaum, Carpenter, Swelling of Rubber Networks in Binary Solvent Mixtures; Theory of Swelling in Solvent Mixtures; J. Polymer Sci., 14:241 (1954)

Kurath, S.F., Passaglia, E., Pariser, R., The Dynamic Mechanical Properties of Hypalon-20 Synthetic Rubber at Small Strains; J. Appl. Polymer Sci., 1:150 (1959)

Kusov, A., et al, Change in the Specific Volume During Extension of Rubber; Colloid J. (U.S.S.R.) 19:587 (1957)

Kusov, A.B., Voronovich, N.I., The Effect of Elongation on the Swelling of Rubber; Trudy Leningrad Tekhnol Inst im. Lensoveta, 41:215-18 (1957)

Kusov, A., Voronovich, N., The Influence of Swelling on the Physical and Mechanical Characteristics of Elastomers; Trudy Leningrad Tekhnol Inst. im Lensoveta 42:47-54 (1957)

Kuvshinskii, E., Sidorivich, E., Effect of Vulcanization on the Dynamic Elastic Properties of Rubber; Soviet Phys.-Tech. Phys., 2:632 (1957)

Landel, Robert L., Stedry, Paul J., Stress as a Reduced Variable: Stress Relaxation of SBR Rubber at Large Strains; J. Appl. Phys., 31:1885 (1960)

Layer ,R. (B.F. Goodrich Co., Brecksville, Ohio) Absence of Cracking of Stressed Rubber by Free Radicals; J. Polymer Sci., 37:546 (1959)

Lazurkin, Y., Ushakov, G., Effect of Radiation on the Properties of Silicone Rubber; Soviet J. At. Energy, 4:365 (1958)

LeBras, J., Salvetti, A., Kinetic Study of the Oxidation of Rubber: I. Some Observations on the Case of Raw Rubber; Presented at the Rubber Technology Conference, London (1948)

Lehl, H., The Swelling Behavior of Rubbers Loaded with Reinforcing Fillers and Their Vulcanizates in Solvents; Kautschuk u. Gummi, 13, WT 164-168 (1960)

Lens, On the Solutions of Rubber Sols: Vapor Pressure Data on Rubber Swelling; Rec. Trav. Chim., 51:971 (1932)

Lewis, Otis Griffin, Coalescence of Latex Particles by Swelling; Univ. Microfilms, L.C. Card No. Mic 60-5629:214, Dissertation Abstr., 21:2128 (1961)

LuKemakaya, A.I., Some Features of the Reinforcing Action of Carbon Blacks Following from the Tear Behavior of Filled Rubbers; Vysokomolekulyarnye Soedineniya, 1:1287 (1959)

Luttropp, H., Swelling and Deswelling of Soft Rubber Vulcanizates; Kautschuk u. Gummi 12 WT 147 WT155 WT 186 WT 190 (1959)

Madorsky, S.L., et al, Pyrolysis of Polyisobutene : Vistanex, Polyisoprene, Polybutadiene, GR-S and Polyethylene in a High Vacuum; J. Research Nat. Bur. Standards, 42:499 (1949)

Madordky, S.L., Rates and Activation Energies of Thermal Degradation of Styrene and Acrylate Polymers in a Vacuum; J. Polymer Sci., 11:491 (1953)

Mandel, J., Stiehler, R., Statistics, A Tool in Testing Rubber; ASTM Bulletin No. 204 (Feb., 1955)

Mark, H., Influence of Molecular Structure on Properties; Ind. Eng. Chem., 44:2110 (1952)

Mason, P., (Brit. Rubber Producers' Research Assocn., Welwyn Garden City, England), Strain Dependence of Rubber Visco-Elasticity: I. Region of Moderate Strain; Trans. Faraday Soc. 55:1461 (1959)

Maynard, J.T., Mochel, W.E., The Structure of Neoprene: VI. Crystallization; J. Polymer Sci., 13:235 (1955)

Medvedeva, A.M., Deryagin, B.V., Zherebkov, S.K., Adhesion Phenomena in Rubber-to-Metal Bonds made with the Leikonat Adhesive: III. Interaction of Sodium-Butadiene Rubber with Triisocyanatotriphenylmethane; Kolloid. Zhur., 22:217 (1960)

Melville, H.W., Bonsall, E.P., Valentine, L., Copolymerization; J. Appl. Chem., 1:249 (1951)

Melville, H.W., Kinetics of Polymerization Reactions in Viscous Systems; Z. Elektrochem., 60:276 (1956)

Melville, H.W., Valentine, F.R.S., Valentine, L., Studies in Copolymerization: II. A Discussion of the Validity of the Results and Some Theoretical Implications;; Proc. Roy. Soc., 200:358 (1950)

Melville, H.W., Valentine, G.R.S., Valentine, L., Studies in Copolymerization: I. Evaluation of the Kinetic Coefficients for the Copolymerization of Styrene and Methyl Methacrylate; Proc. Roy. Soc., 200:337 (1950)

Mercuric, A., Toblosky, A. (Princeton Univ., Princeton, N.J.), Stress Relaxation Studies of Scission in Rubber Vulcanizates; J. Polymer Sci., 36:467 (1959)

Meyer, J., Taylor, J., Effect of Highly Aromatic Gasolines on Fuel Hose Compounds; Rubber World, 140:573-8 (1959)

Meynard, C. Thelamen, Brominated Butyl Rubber; Rev. gen. caoutchouc, 35:620 (1958)

Michaelsen, J.D., Wall, L.A., Further Studies on the Pyrolysis of Polytetrafluoroethylene in the Presence of Various Gases; J. Research Nat. Bur. Standards, 58: (June, 1957)

Mochel, W.E., Petersen, J.H., The Structure of Neoprene: II. Determination of End-Groups by Means of Radiosulfur; J. Am. Chem. Soc., 71:1426 (1949)

Mochel, W.E., Nichols, J.B., TheStructure of Neoprene: IV. The Molecular Weight Distribution of Neoprene Type CG; J. Am. Chem. Soc., 71:435 (1949)

Mochel, W.E., Nichols, J.B., Mighton, C.J., The Structure of Neoprene: I. The Molecular Weight Distribution of Neoprene Type GN; J. Am. Chem. Soc., 70:2185 (1948)

Mochel, W. E., Structure of Neoprene: V. Viscosity-Conversion Relationships in Sulphur-Modified Polychhoroprenes; J. Polymer Sci., 8:583 (1952)

Mooney, M., Rheology of Raw Rubber; Physics, 7:413 (1936)

Moore, C.G., Scanlan, J., Determination of Degree of Cross-Linking in Natural Rubber Vulcanizates: VI. Evidence for Chain Scission During the Cross-Linking of Natural Rubber with Organic Peroxides; J. Polymer Sci., 43:23 (1960)

Moran, A.L., Viton A-Effect of Fillers on Heat and Fluid Resistance; Rubber World, 137:250 (1957)

Morris, R.S., Barrett, A.E., Effect of Arctic Exposure on Hardness of Elastomer Vulcanizates; India Rubber World, (March, 1954)

Mullins, L., Determination of Degree of Cross-Linking in Natural Rubber Vulcanizates: IV. Stress-Strain Behavior at Large Extensions; J. Appl. Polymer Sci., 2:257 (1959)

Mullins, L., Thomas, A.G., Determination of Degree of Cross-Linking in Natural Rubber Vulcanizates: V. Effect of Network Flaws Due to Free Chain Ends; J. Polymer Sci., 43:13 (1960)

Mullins, L., Turner, D.T., Radiation Cross-Linking of Rubber: III. Chain Fracture; J. Polymer Sci., 43:35 (1960)

Mullins, L., Swelling of Rubber Networks in Binary Solvent Mixtures: Polymer Swelling in Pure Solvents; J. Polymer Sci., 19:225 (1956)

Nedyalkova, K., Influence of Various Types of Carbon Black on the Physicomechanical Properties of Vulcanized Natural Rubber in Combination with Buna S_4 with the Object of Producing High Modular Mixtures for Frame and Protector: I. Influence of Carbon Blacks on the Physicomechanical Properties of Vulcanized Buna S_4; Khim. i Ind., 32:10 (1960)

Nedyalkova ,K., Influence of Various Types of Carbon Black on the Physicomechanical Properties of Vulcanized Natural Rubber in Combination with Buna S_4 with the Object of Producing High Modular Mixtures for Frame and Protector: II., Influence of the Relation Between Elastomers of Natural Rubber and Buna S_4 on the Physicomechical Properties of the Vulcanizates; Khim. i Ind., 32:48 (1960)

Nelson, K.V., Poddubny, I. Ya., et al, Microstructure of Butadiene Rubbers; Kauchuk i Rezina, 17:3 (1958)

Newing, M.J., Thermodynamic Studies of Silicones in Benzene Solutions; Trans. Faraday Soc., 46:613 (1950)

Novikova (State Med. Inst. Minsk) The Swelling of Vulcanized Rubber in Acetyl Hydroperoxide Solution; Kolloid Zhur 21:91 (1959)

Oakes, W.G., Richards, R.B., The Dielectric Properties of Chlorinated Polythenes at Radio Frequencies; Trans. Faraday Soc., 42a:197 (1946)

O'Mahoney, Joseph F. Jr., Adhesion of Butyl Rubber Cured with Bis (Hydroxymethyl) - Phenols to Copper and Copper-Containing Alloys; U.S. 2,960,426 (Nov. 15, 1960)

Orofino, T.A., Flory, P.J., Relationship of the Second Virial Coefficiant to Polymer Chain Dimensions and Interaction Para-Meters; J. Chem. Phys., 26:1067 (1957)

Oth, Jean F.M., Thermodynamics of Reversible Elastic Deformations of Materials in Equilibrium with an Excess of the Swelling Agent; J. Chim. Phys., 57:720 (1960)

Park, G.S., A Method for the Measurement of Diffusion Coefficients in Polymer Solvent Systems Under Conditions of Constant Chemical Composition; Radioisotope Conf., 2:11 (1954)

Park, G.S., Radioactive Studies of Diffusion in Polymer Systems: II. The System Isopentane + Polyisobutene; Trans. Faraday Soc., 53:107 (1957)

Park, G.S., The Determination of the Concentration Dependent Diffusion Coefficient for Methylene Chloride in Polystyrene by a Steady State Method; Trans. Faraday Soc., 48:11 (1952)

Park, G.S., The Diffusion of Some Halo-Methanes in Polystyrene; Trans. Faraday Soc., 46:684 (1950)

Park, G.S., The Diffusion of Some Organic Substances in Polystyrene; Trans. Faraday Soc., 47:1007 (1951)

Parks, W., Richards, R.B., The Effect of Pressure on the Volume: Thermodynamic Properties and Crystallinity of Polythene; Trans. Faraday Soc., 45:203 (1949)

Pinner, S., Stress-Strain Properties of Irradiated Filled Natural Rubber; Intern. J. Appl. Radiation and Isotopes 5:121 (1959)

Pisarenko, A.P., Emelyanova, A.P., Technical Properties of Synthetic Rubber and Oil-Extended Synthetic Rubber Containing Silica; Nauch. Issledovatel. Trudy Tsentral. Nauch. Issledovatel. Inst. Zamenitelelkozhi, Sbornik, 9:110 (1958)

Poddubnyi, I. Ya., Erenburg, E.G., Branching in Macromolecules of Different Synthetic Rubbers; J. Polymer Sci., 29:605 (1958)

Poddubnyi, I., Erenburg, E., Thermodynamic Study of the Compatibility of Various Rubbers with Mineral Oils; Kauch. i Rezina 18 6:16 (1959)

Posnjak, Uber den Quellungsdruck; Koll. Beihefte, 3:417 (1912)

Powell, A. (Case Inst. of Technol., Cleveland, Ohio), Analysis of Rubber and Plastics by Physical Methods; ISA Natl. Symposium Instrumentation Rubber Plastics Ind. Cleveland 1957, 13:32

Powers, P.O., Billmeyer, B.R., Swelling of Synthetic Rubbers in Mineral Oils. Effect of Temperature and Aniline Point; Ind. Eng. Chem., 37:64 (1945)

Powers, P. O., Robinson, H.A, Swelling of Synthetic Rubbers in Mineral Oils. Swelling in Mineral Oils Containing Polyolefins and in Mixtures of Nujol and Diphenyl; Ind. Eng. Chem., 34:614 (1942)

Prager, S. Long, F.A., Diffusion of Hydrocarbons in Polyisobutylene; J. Amer. Chem. Soc., 73:4072 (1951)

Prager, S. Bagley, E., Long, F.A., Equilibrium Sorption Data for Polyisobutylene- Hydrocarbon Systems; J.Am. Chem. Soc., 75:2742 (1953)

Prendergast, J.J., Gasoline versus Elastomers; Rubber Age, 84: 619-26 (1959)

Price, F.P., A Light Scattering Investigation of Crystal Growth in Polyethlene; Growth & Perfection of Crystals, John Wesley and Sons, New York (1958)

Price, F.P., Calculation of Degree of Crystallinity in Polymers from Density Measurements; J. Chem. Phys., 19:973 (1951)

Price, F.P., Light Scattering From Crystallizing Polymers; J. Phys. Chem., 59:191 (1955)

Rady, A. (Ain Shams Univ., Cairo), Dynamic Properties of the New Rubber-like Irradiated Polyethylene, J. Appl. Polymer Sci., 1:129 (1959)

Railsback, H.E., Haws, J.R., Wilder, C.R., Properties of High-Trans Polybutadiene; Rubber World, 142:67 (1960)

Rehner, J.Jr., Heat Conduction and Molecular Structures in Rubberlike polymers; J. Polymer Sci., 2:263 (1947)

Reynolds, W.W., Gebhart, H.J.Jr., Effect of Solvent Properties on the Viscosity of Concentrated Natural Rubber Solutions; J. Chem. Eng. Data, 5:220 (1960)

Reznikovskii, M., Mechanical Properties of Elastomers Under Dynamic Stress; Khim Nauka i Prom, 4:79 (1959)

Reznilovskii, M., Priss, L., Khromov, M., The Connection Between Fatigue Resistance, Strength Hysteresis and Chemical Stability of Rubbers; Kolloid Zhur 21:459 (1959)

Richards, R.B., Orineted Overgrowth on Cold-Drawn Polymers; J. Polymer Sci., 6:397 (1951)

Richards, R.B., The Phase Ewuilibris Between A Crystalline Polymer and Solvents: I. The Effect of Polymer Chain Length on the Solubility and Swelling of Polythene; Trans. Faraday Soc., 42:10 (1946)

Roberts, D.E., Mandelkern, L., Thermodynamics of Crystallization in High Polymers; Natural Rubber; J. Am. Chem. Soc., 77:781 (1955)

Robinson, H.W.H., Vodden, H.A., Stress Relaxation in Rubber; Evaluation of Antioxidants; Ind. Eng. Chem., 47:1477 (1955)

Root, L., Glikman, S., Delatometric Investigation of Swelling Processes of Acrylonitrile Rubbers and Poly (vinyl butyral); Nauch Ezhagodnik Za 1954 Saratov Univ. (Saratov) 1955 558, Referat. Zhur. Khim. 1956

Rostler, F.S., Rostler, K.S., Morrison, R.E., White, R.M., Swelling of Rubber: II. A Comparison of the Swelling Behavior of Vulcanized Natural Rubber and GR*S in Organic Liquids; Rubber Age, (June, 1946)

Rostler, F.S., Morrison, R.E., Swelling of Rubber: IV. Effect of Carbon Blacks on the Swelling of Vulcanized GR-S; Rubber Age, (April, 1947)

Rostler, F.S., Rostler, K.S. Swelling of Rubber: III. The Swelling Behavior of Vulcanized Natural Rubber and GR-S in Mixtures of Hydrocarbons; Rubber Age, (Oct., 1946)

Roush, C., Braley, S. (Dow Corning Corp., Midland, Mich.), Compression Set of Silicone Rubber; Rubber Age N.Y. 84:75 (1958)

Sack, R.A., Statistics of Imperfectly Flexible Molecular Chains; J. Chem. Phys., 25:1087 (1956)

Salimov, M.A., Zhuravskaya, E.G., Kuzminskii, A.S., Structural Changes of Sodium-Butadiene Rubber under the Action of Ionizing Radiations; Vestnik Moskov. Univ., Ser. Mat., Mekh. Astron., Fiz. i. Khim., 14:177 (1959)

Salomon, G., Analysis of Rubber Structures; Proc. Inst. Rubber Ind., 3:176 (1956)

Salomon, G., Beziehunger Zwischen Struktur and Mechanischen Eiglin Schaften von Kautschuk und Kautschukdevivatien; Schweiz Arch Angew, Wiss. u. Tech., 16:161 (1950)

Salomon, G., Correlation Entre la Structure et les Preoprietes Mecaniques des Polymeres an Chaine; Chim & Ind. (Paris) Special Number for the 21st International Congress of the Chemical Industry

Salomon, G., Influence of Structure on Polymer Liquid Interaction: II. Influence of Nitrile Groups; J. Polymer Sci., 3:173 (1948)

Salomon, G., Ultee, A.J. Sr., Kinetic Analysis of Organic Halides: III. Analysis of Low Molecular Polyhalides; Rec. Trav. Chim., 70:1 (1951)

Salomon, G., Koningsberger, C., Kinetic Analysis of Organic Halides: IV. Analysis of Macromolecular Polyhalides; Rec. Trav. Chim., 70:545 (1951)

Salomon, G., Koningsberger, C., Kinetic Analysis of Organic Halides: II. Analysis of Macromolecules Built up of Monohalide Units; Rec. Trav. Chim., 89:712 (1950)

Salomon, G., Ontwikkeling en Perspectieven op Het Gebied van Rubberderivaten; Chem. Weekblad, 48:292 (1952)

Salomon, G., Polymerization Induced by Silver Salts; Rec. Trav. Chim., 68:903 (1949)

Salomon, G., Koningsberger, C., Preparation and Properties of Rubberlike High Polymers: IV. Correlation Between Structure and Properties of Elastomers Derived from Dienes; J. Polymer Sci., 2:522 (1941)

Salomon, G., Preparation and Properties of Rubberlike High Polymers: V. Influence of Nitrile Groups on the Properties of Copolymers; J. Polymer Sci., 3:32 (1948(

Salomon, G., Boontra, B.B.S.T. van der Meer, S., Ultee, A.J., Preparation and Properties of Rubberlike High Polymers: VI. Polymerization and Dimerization of Isoprene; J. Polymer Sci., 4:203 (1949)

Salomon. G., Koningsberger, C., Preparation and Properties of Rubber-like High Polymers: III. Polymerization of Mixtures in Emulsion; J. Polymer Sci., 1:364 (1946)

Salomon, G., Quantitative Determination of Organic Ha[illegible] 77:1017 (1952)

Salomon, G., Reactivity and Structure of Dienes and Their Polymers: I. Reactivity of II-Complex Compounds; Discussions Faraday Soc., 2:353 (1947)

Sauer, J.A., Marin, J., Hsiao, C., Creep and Damping Properties of Polystyrene; J. Appl. Phys., 20:507 (1949)

Saunders, D.W., The Photo-Elastic Properties of Cross-Linked Amorphous Polymers: III. Interpretation of Resluts on Polythene Polymethylene, Natural Rubber, and Gutta Percha; Trans. Faraday Soc., 53:860 (1957)

Saunders, D.W., The Photo-Elastic Properties of Cross-Linked Amorphous Polymers: I. Natural Rubber and Gutta-Percha: II. Polythene and Polymethylene; Trans. Faraday Soc., 52:1414 (1956)

Saunders, D., The Photoelastic Properties of Rubber-Like Polymers; Rheol. Elastomers Proc. Conf., Welwyn Garden City, 1957 (P. Mason and N. Wookey, ed., 1958)

Saunders, W. (Brit. Rayon Research Assocn., Manchester, Engl.) Optical Properties of Strained Amorphous Polymers; Soc. Chem. Ind. (London) Monograph 5:15 (1959)

Scanlan, J., Merrett, F.M., The Interaction of Polymerizing Systems with Rubber and its Homologues: I. The Effect of Dihydromyrcene on the Polymerization of Styrene, Methyl Methacrylate, Methyl Acrylate and Vinyl Acetate. II. Interaction of Rubber in the Polymerization of Methyl Methacrylate and of Styrene; Trans. Faraday Soc., 50:756 (1954)

Scholle, W., Hillner, K. (Tech. Hochschule, Hannover, Ger.) The Vulcanization of Elastomers: XXIII. The Chemical Kinetics of Vulcanization Reactions and the Physical Properties of the Vulcanizates; Kautschuk u. Gummi 12 WT 1-4 (1959)

Schultz, Flory, Swelling of Rubber Networks in Binary Solvnet Mixtures; Flory-Huggins Theory; J. Amer. Chem. Soc., 75:3888 (1953)

Schvetsov, V.A., Pisarenko, A.P., Novidov, A.S., Properties of Reinforced Nitrile Rubb : I. Properties of Reinforced Silicate-Nitrile Rubbers, Kauchuk u. Rezina 18 12:4-8 (1959)

Shavarts, A., Buiko, G., Dogadkin, B., Dependence of Physical Properties of SKI Rubbers on the Concentration of Cross-Links; Kauchuk i Rezina 18 6:25 (1959)

Shiramatsu, Toyotaro, Tameda, Tsuneo, Tadokoro, Tomio, Rubber-Styrene Casting Resin Effect of Curing Condition on Properties; Nippon Gomu Kyokaishi; 33:188 (1960)

Shvarts, A., Nomograms for the Determination of the Density of the Three Dimensional Lattice of Vulcanizates; Kauchuk i Rezina 16 7:31 (1957)

Shvetson, V.A., Pisarenko, A.P., Novilov, A.S., Properties of Reinforced Nitrile Rubbers: I. Properties of Reinforced Silicate-Nitrile Rubbers; Kauchuk i Rezina, 18:4 (1959)

Simba, R., Wall, L.A., Bram, J., High Speed Computations in the Kinetics of Free-Radical Degradation: I. Random Initiation; J. Chem. Phys., 21:894 (1958)

Smallwood, H.M. Limiting Law of the Reinforcement of Rubber; J. Appl. Phys., 15:758 (1944)

Smith, F. (Firestone Tire and Rubber Col, Akron, Ohio) Properties of Elastomers up to 550°F; Rubber World 139 533:669 (1959)

Smith, T. Dependence of the Ultimate Properties of an SBR Rubber on Strain and Temperature; J. Polymer Sci. 32:99 (1958)

Smith, T.L., and Magnusson, A.B., Diisocyamate-linked Polymers: II. Mechanical and Swelling Properties of some Polyurethan Elastomers; J. Polymer Sci., 42:391-416 (1960)

Societe Auxiliaire de l'institut Francais du Caoutchouc, Improvement of Mechanical Properties of Elastomers by Formation of Resinous Condenstation Products in Dry Rubber; Fr. 1,187,648 (Sept. 14, 1959)

Stamberger, J.C.S., A Study of the Vapor Pressure Diminution of Rubber Jellies; Trans. Faraday Soc., 132:II:2318 (1929)

Starobinets, G.L., Tikavyi, V.F., Effective Sorption of Binary Solutions by Rubber Depending upon the State of Cure and Loading with Fillers; Uchenye Zapiski Belorus. Gosudarst. Univ. im. V.I. Lenina, Ser. Khim., 29:178-88 (1956)

Starobinets, G.L., The Composition of Adsorption Layers on the Solution-air Boundary in Systems of the Type Solvent-nonsolvent for Rubber; Uchenye Zapiski Belorus. Gosudorst. Univ. im. V.I. Lenina, Ser. Khim., 42:139-50 (1958)

Starobinets, G.L., Tikavyi, V.F., The Dielectric Constant of the System: Rubber-like High Polymer-solvent-nonsolvent; Doklady Akad. Nauk Belorus S.S.R., 3:249:52 (1959)

Starobinets, G.L., The Nature of the System Rubbery High Polymer: Binary Micture of Low-molecular Components. The Distribution of the Low-Molecular Components between Polymer and Binary Solution; Uchenye Zapiski Belorus. Gosudorst. Univ. im. V.I. Lenina, Ser. Khim., 42:151-8 (1958)

Straka, L.E., Rubber Developments: A Review of the Literature for 1957-59; Mech. Eng., 82:71-7 (1960)

Straus, S., Wall, L.A., Pyrolysis of Polyamides; J. Research Nat. Bur. Standards 60, (Jan. 1958)

Straus, S., Madorsky, S.L., Pyrolysis of Styrene, Acrylate, and Isoprene Polymers in a Vacuum; J. Research Nat. Bur. Standards, 50:165 (1953)

The Structure and Reaction of Rubber - A General Discussion; Trans Faraday Soc., 38:269-387 (1942)

Thiokol Chemical Corp., Study of the Effect of High Aromatic Fuels on Elastomers; Polysufide Rubber Bulletin (Jan., 1959)

Thirion, P., Chasset, R. (Inst. francais caoutchous, Paris) Thermodynamics of Rubber in Extension: A Relation Between Tension and Temperature at Equilibrium I. Reversibility and Method of Analysis; Rheol. Elastomers, Proc. Conf., Welwyn Garden City 1957 (P. Mason and N. Wookey, ed., 1958) p. 17

Trapeznikov, A., Assonova, T. (Inst. Phys. Chem. Acad. Sci. U.S.S.R., Moscow) Strngth and High Elastic Properties of Solutions of Rubber and Vulcanizates at High Rates of Deformation, Kolloid Zhur 20:398 (1958)

Trapenikov, A., Assonova, T., Stress-Strain and Viscous Properties of Rubber Solutions; Kolloid Zhur. 21:485 (1959)

Treloar, L.R.G., The Absorption of Water by Hair, and its Dependence on Applied Stress; Trans. Faraday Soc., 48:567 (1952)

Treloar , L.R.G., The Equilibrium Swelling of Cross-Linked Amorphous Polymers; Proc. Roy. Soc., 200:176 (1950)

Treloar, L.R.G., The Photoelastic Properties of Short-Chain Molecular Networks; Trans. Faraday Soc., 50:881 (1954)

Treloar, L., The Present Status of the Theory of Large Elastic Deformations; Rheol. Elastomers. Proc. Conf. Welwyn Garden City 1957 pp. 1-16 (P. Mason and N. Wookey ed., 1958)

Treloar, L.R.G., The Serlling of Cross-Linked Amorphous Polymers Under Strain; Trans. Faraday Soc., 46:783 (1950)

Tuckett, R.G., The Degradation of High Polymers; Trans. Faraday Soc., 41:351 (1945)

Ueberreiter, K., Kanig, G., Die Kettenlangenabhangigkeit des Volumerns, des Ausdehnungskoeffizienten und der Einfriertemperatur von Fraktionierten Polystyrolen; Fa Naturforsch., 6a: 551 (1951)

Ueberreiter, K., Kanig, G., Second-Order Transitions and Mesh Distribution Functions and Cross-linked Polystryenes; J. Chem. Phys., 18:399 (1950)

Ueberreiter, K., Kanig, G., Self-Plasticization of Polymers; J. Colloid Sci., 7:569 (1952)

United States Rubber Co., Adhesion of Butyl Rubber to Other Elastomers; Brit. 853,215 (Nov. 2, 1960)

Uret, R.B., Bloom, W., Zirkle, R.E., Irradiation of Parts of Individual Cells: II. Effect on an Ultraviolet Microbean Focused on Parts of Chromosomes; Science, 120:197 (1954)

Vasilev, Az., Nedyalkova, K., The Effect of Various Types of Carbon Black on the Physical Properties of High-Modulus Carcass, Breaker and Protector Mixtures Based on Natural Rubber; Leka Prom., 8:15 (1959)

Veith, A.G., Chain Scission Efficiency in the Oxidation of Natural Rubber Vulcanizates; J. Polymer Sci., 25:355 (1957)

Vinogradov, P.A., Paskhalis, T.K., Kostina, S.I., Properties of Butadiene-Acrylonitrile Copolymers; Kauchuk i Rezina, 17:5 (1958)

Volkova, L.A., Volkenshtein, M.V., X*Ray Investigation of Swelling of Natural Rubber; Fiz. Tverdogo Tela, 1:1272 (1959)

Votinov, M., Kuvshinskii, E., Laws Governing the Conversion of Work into Heat in the Adiabatic Deformation of Butyl Rubber Vulcanizates; Soviet Phys. Tech. Phys., 2:2375 (1957)

Wagner , H.H., Flory, P.J., Molecular Dimensions of Natural and Gutta Percha; J. Am. Chem. Soc., 74:195 (1952)

Wagner, Melvin P., Kinetics of Filler-Polymer Interaction Between Fine Particle Silica and SBR or Butyl Rubber; Ind. Eng. Chem., 51:961 (1959)

Wakeham, H., Honold, E., Portas, H.J., Moisture Relations of Tire Cords in Tires; India Rubber World 113:659 (1946)

Wall, F.T., Miller, D.G., Applied Force and Second Order Trabsutions of Rubber; J. Polymer Sci., 13:157 (1954)

Wall, F.T., Powers, R.W., Sands, G.E., Stent, G.S., Properties of Polymers as Functions of Conversion: IV. Composition Studies of Rubberlike Copolymers; J. Am. Chem. Soc., 70:1031 (1948)

Wall, F.T., Powers, R.W., Sands, G.D., Stent, G.S., Properties of Polymers as Functions of Conversion: II. Intrinsic Viscosities; J. Am. Chem. Soc., 69:904 (1947)

Wall, F.T., Beste, L.F., Properties of Polymers as Functions of Conversion: III. Molecular Weights of Bottle Polymerized GR-S; J. Am. Chem. Soc., 69:1761 (1947)

Wall, F.T., Statistical Lengths of Rubber-like Hydrocarbon Molecules; J. Chem. Phys., 11:67 (1943)

Wall, F.T., Statistical Thermodynamics of Rubber; J. Chem. Phys., 10:132 (1942)

Wall, F.T., Statistical Thermodynamics of Rubber. II. J. Chem. Phys., 10:485 (1942)

Wall, F.T., Statistical Thermodynamics of Rubber. III. J. Chem, Phys., 11:527 (1943)

Wall, F.T., Flory, P.J., Statistical Thermodynamics of Rubber Elasticity; J. Chem. Phys., 19:1435 (1951)

Wall, L.A., Brown, D.W., Chemical Activity of Gamma- Irradiated Polymethyl Methacrylate; J. Research Nat. Bur. of Standards 57: (Sept., 1956)

Wall, L.A., Magat, M., Effects of Atomic Radiation on Polymers; Modern Plastics, (July, 1953)

Wall, L.A., Florin, R.E., Effect of Structure on the Thermal Decomposition of Polymers; J. Research Nat. Bur. Standards, 60:451 (1958)

Wall, L.A., Brown, D.W., Hart, V.E., Pyrolysis of S-and B-Deuterostyrene Polymers; J. Polymer Soc., 15:157 (1955)

Wall, L., Pyrolysis of Copolymers; Nat. Bur. Standards Circ. 525 (1953)

Wall, L.A., Tryon, M., Thermal and Photochemical Processes in Polystyrone in the Glassy State; Natura, 178:101 (1956)

Wall, L.A., Michaelsen, J.D., Thermal Decomposition of Polytetrafluoretylene in Various Gaseous Atmospheres; J. Research Nat. Bur. Standards, 56: (Jan., 1956)

Warrick, E.I., Effects of Radiation on Organopolysiloxanes; Ind. Eng. Chem., 47:2388 (1955)

Watson, W.F., Chain-Length Distribution Functions of Polymers after Random Degradation and Cross-Linking, with Particular Reference to Elastomers; Trans. Faraday Soc., 49:1369 (1953)

Weinreb, A., Avivi., P., Comparison Between Energy Transfer in Liquid and Plastic Solutions; Liquid Scintillation Counting :270 (1958)

Weinreb, A., Transfer of Molecular Energy Between Solutes in Liquids; J. Chem. Phys., 28:731 (1958)

Will, D.W., Biship, F., Bogen, E., Djang, A.H.K., Carpenter, C.M., Comparative Morphology of Acid-Fast Bacilli; Diseases of the Chest, 19:387 (1951)

Wilson, A., Griffis, C.B., Montermoso, J.C., Effect of Swelling on the Properties of Elastomers; Rubber World (Oct., 1958)

Woo, H.K., Dusenbury, J.H., Dillon, H.H., The Reaction of Formaldehyde with Celluloic Fibers: I. Rate and Mechanism of the Reaction: II. Mechanical Behavior; Textile Research J., 26:745 (1956)

Wood, L.A., Physics, The Elasticity of Rubber; J. Wash. Acad. Sci., 47:281 (1957)

Wood, L.W., Tilton, L.W., Refractive Index of Natural Rubber for Different Wavelengths; J. Res. Nat. Bureau Stds., 43:57 (1949)

Wormuth, Wilbur J., Low-Shrinkage Silicone Rubber Compositions; U.S. 2,938,011 (May 24, 1960)

Yakubchik, A.I., Filatova, V.A., Chemical Structure of Various Fractions of Sodium-Butadiene Rubber; Zhur. Obshchei Khim., 29:2658 (1959)

Yamashita, S., et al (Univ. Kyoto) Improvement of Butyl Rubber; Nippon Gomu Kyokaishi 31:892 (1958)

Zashunskaya, F.I., Markovich, G.A., High-Elasticity Synthetic Rubbers as Compared with Butadiene-Styrene; Kauchuk i Rezina, 18:1 (1959)

Zamarov, V. (Inst. Chem., Minsk) Dependence of Swelling Isotherms and Equilibrium Curves on Pressure; Kolloid Zhur. 21:298-300 (1959)

Zanamonets, N., Fogel, V., Theromophysical Characteristics and Thermal Effects of Reaction of Vulcanization of Hard Rubber Compositions from Styrene-Butadiene Rubber; Kauchuk i Rezina 18 No. 2:21 (1959)

Zapas, L.J., Shufler, S.L., DeWitt, T.W., A Comparison of the Dynamic Properties of Natural Rubber and GR-S; J. Polymer Sci., 18:245 (1955)

Zapp, R. (Esso Research and Eng. Co., Linden, N.J.) Dynamic Properties of Butyl Rubber Vulcanizates and Their Applications; Kautschuk u Gummi 12 WT 36-41 (1959)

Zapp, R., Dynamic Properties of Butyl Rubber and Their Applications; Proc. Inst. Rubber Ind., 5:172 (1958)

Zimm, B.H., Lundberg, J.L., Sorption of Vapors by High Polymers; J. Phy. Chem., 60:425 (1956)

Zirkle, R.E., Bloom, W., Irradiation of Parts of Individual Cells; Science, 117:487 (1953)

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BIBLIOGRAPHY

Albert, H.E., Effect of Certain Antioxidants in GR-S; Ind. Eng. Chem., 40:1746 (1948)

Albert, H.E., Smith, G.E.P., Gottschalk, G.W., Effect of Iron on Aging of GR-S; Ind. Eng. Chem., 40:482 (1948)

Ambelang, Joseph C., Reaction Products of Alkylene Dihalides and Substituted Phenylenediamines for use as Antiozonants in Rubber; U.S. 2,939,867 (June 7, 1960)

Ameronger, G.J. van, The Influence of Carbon Black on Oxidation Hysteresis and Wear of Rubber; Paper presented at the "Symposium on Carbon Blacks" of the Sveriges Gummitekniska Forenings, (Nov., 1954) Stockholm

Andakushkin, V.Ya., Savel'ev, A.I., et al, An Improved Method of Producing Copolymers of Butadiene and Acrylonitrile: II. Production of SKN-26 Rubber by Continuous Polymerization; Kauchuk i Rezina, 18:6 (1959)

Anderson, R.B., Emmett, P.H., Surface Complexes on Carbon Blacks: I. High Temperature Evacuation Studies; J. Phys., Chem., 56:753 (1952)

Anderson, R.B., Emmett, P.H., Surface Complexes on Carbon Blacks; II. The Absorption of NH_3, C_2H_2, C_4H_{10}, CH_3NH_2 and Water Vapor; J. Phys. Chem., 56:756 (1952)

Anon., Petroleum Raw Materials for the New Synthetic Rubbers; Oil in Can, 13:28 (1961)

Ashikari, Nobuyuki, Polymerization of Olefins with Trialkyboron Catalyst: III. Copolymerization of Butadiene, Isobutylene, and 1- phenylbutadiene; Bull. Chem. Soc. Japan, 32:1060 (1959)

Auerbach, I., Gehman, S.D., Tracer Method for Sulfur Solubility and Diffusivity in Rubber; Anal. Chem., 26:685 (1954)

B.F. Goodrich Co., Rubbery Material Reinforced with Pigments Containing Silicon and Oxygen; Brit. 855,424 (Nov. 30, 1960)

B.F. Goodrich Co., Silicon-Oxygen Compounds as Reinforcing Pigments for Elastomers; Ger. 1,041,019 (Oct. 16, 1958)

B.F. Goodrich Co., Solid Disproportionated Silicon Monoxide; Brit. 828,723 (Feb. 24, 1960)

B.F. Goodrich Co., Solid, Fibrous, Nitrogen-Containing Silicon Monoxide for Rubber Reinforcement; Ger. 1,040,004 (Oct. 2, 1958)

B.F. Goodrich Co., Stable Latexes from Acrylonitrile and Butadiene; Ger. 1,055,241 (Apr. 16, 1959)

Babanov, G.P., Tekhnika besopasnosti i gigiena truda v proizvodstve sinteticheskogo divinil-nitril'nogo Kauchuka (Accident Prevention and Sanitation in the Production of Synthetic Butadiene Nitrile Rubber); Moscow, Gosudarst. Nauch.-Tekh. Izdatel. Khim. Lit., :11 (1960)

Bailey, Donald L., Black, Wm. T., Dunham, Milton L., Dialkyl Peroxide - Cured Silicone Elastomers; Brit. 819,245 (Sept. 2, 1959)

Bartha, Zoltan, New Synthetic Rubbers; Magyar Kem. Lapia, 15:446 (1960)

Barton, B.C., Hart, E.J., Variables Controlling the Cross-Linking Reactions in Rubber; Ind. Eng. Chem., 44:2444 (1952)

Baum, Sidney J., Moldable Compositions from Styrene and Styrene-Rubber Interpolymers; U.S. 2,957,833 (Oct. 25, 1960)

Bean, C., Etude de L'Action de Certains Desactiveurs et Antioxyienes Speciaux Sur le Vieillissement dt la coloration des Melanges Blancs; Rev. Gen. Caoutchouc, 31:49 (1954)

Beaver, David, Stoffel, Paul J., Nitrosoamines as Addatives to Rubber to Prevent Cracking Under Stress; U.S. 2,931,785 (Apr. 5, 1960)

Bergstrom. E.W., Antiozpnants for Nitrile and Natural Rubbers; Rock Island Arsenal Lab. Tech. Rpt. 21: (Jul., 1956)

Bergstrom, E.W., Preservation of Tires in Outdoor Storage at Rock Island, Ill.; Rock Island Arsenal Lab. Tech. Rpt. 58:106

Berman, M.L., Rachkulik, V.I., Luminescence Method for the Control of Rubber Composition; Kauchuk i Rezina 16 12:33-6 (1957)

Berry, J.P., Cairre, P.J., The Interaction Between Styrene-Betaidiene Rubber and Carbon Black on Heating; J. Appl. Polymer Sci., 3:213 (1960)

Blanchard, A.F., Role of Particle Diameter and Linkage Formation in Rubber Reinforcement; Proceedings of the Third Rubber Technology Conference (1954)

Bogomolov, B.D., Utilization of Alkaline Sulfate Lignin as a Filler in Synthetic Rubber; Izvest. Vysshikh Ucheb. Zavedenii, Lesnot Zhur., 2:150 (1959)

Boguslavskii, D.A.B., Lazzryants, E.G., et al, Synthetic Rubber, not Requiring Thermoplastication; Yaroslavskaya Prom., :27 (1958)

Boldyreva, I.I., Dolgoplosk, B.A., et al, Cis-Trans Isomerization of Natural Rubber Under the Action of Hydrogen Chloride and Ethylaluminum Dichloride; Doklady Akad. Nauk S.S.S.R., 131:830 (1960)

Borisov, S.N., Stavitskii, I.K., et al, Cold-Resistant Polysiloxane Rubber; U.S.S.R. 132,405 (Oct.5, 1960)

Breitenbach, J.W., Preussler, H., Influence of Activated Carbon on Styrene Polymerization; J. Polymer Sci., 4:751 (1949)

Breitenbach, J.W., Preussler, H., Uber die Zersetzung uon Benzoylperoxyd durch Aktivkohle; Osterr. Chemiker-Z., 51:1750 (1950)

British Resin Products Ltd., Acrylates of Phenoxy Alcohol Ethers and Polymers thereof; Brit. 828,496 (Feb. 17, 1960)

Brock, M.J., Louth, G.D., Identification of Accelerators and Antioxidants in Compounded Rubber Products; Anal. Chem., 27:1575 (1955)

Brodkey, Robert S., Miller, Alfred L., Stable Butyl Rubber Latexes; U.S. 2,936,265 (May 10, 1960)

Bueche, A.M., Filler Reinforcement of Silicone Rubber; J. Polymer Sci., 25:139 (1957)

Burgess, K.A., Sweitzer, C.W., Inhibition of Rubber oxidation by Carbon Black; Ind. Eng. Chem., 47:1820 (1955)

Burke, Oliver W., Compounding of Vulcanizable Elastomers; Brit. 844,164 (Aug. 10, 1960)

Casefort, Z.T., Shaw, R.F., Bergstrom, E.W., Curing Systems for Inproved Aging Resistance of Rubber Vulcanizates; Rubber World; (March, 1957)

Chemische Werke Huls Akt.-Ges., Butadiene-Styrene Rubber; Ger. 1,082,413 (May 25, 1960)

Clark, R.A., Dennis, J.B., Compounding Acrylonitrile-Type Rubber for Low Temperature Flexibility; Ind. Eng. Chem., 43:771 (1951)

Clark, R.A., Cheyney, L. E., Compounding of O-Rings Hydraulic Packings; Rubber Age, (Aug., 1949)

Cleverley, B., Herrmann, Romana, Rapid Identification of Elastomers and Their Addatives; J. Appl. Chem., 10:192 (1960)

Cobb, Joseph R. Jr., 1,3-Butadiene; U.S. 2,963,522 (Dec. 6, 1960)

Cohan, L.H., Steinberg, M., Determination of Rate of Cure for Natural and Synthetic Rubber; Ind. Eng. Chem., 16:15 (1944)

Cohan, L.H., Fundamental Properties of Carbon Black Relation to Behavior in Rubber; India Rubber J., (Nov., 1947)

Cohan, L.H., Effect of Pigments of Elastomer Properties; Institution of the Technology Conference, London, (June, 1948)

Cohan, L.H., Steinberg, M., Reinforcement of Natural and Synthetic Rubber - Effect of Paritcle Size of Channel Blacks; Rubber Age and Synthetics (Jan., 1945)

Cohan, L.H., Watson, J.H.L., Shape Factor and Other Fundamental Properties of Carbon Black; Rubber Age, (March, 1951)

Cohan, L.H., Smith, E.E., The Effect of Pigments on the Hardness of Natural and Synthetic Rubbers; Rubber Age, :465 (July, 1948)

Cohan, L.H., The Mechanism of Reinforcement of Elastomers by Pigments; India Rubber W., 117 (1947)

Connecticut Hard Rubber Co., Silicone Rubber Compounds; Brit. 827,632 (Feb. 10, 1960)

Cottle, Belmer L., Minckler, Leon S. Jr., Lemisaka, Theodore, Bromination of Butyl Rubber; U.S. 2,962,482 (Nov. 29, 1960)

Cotton, F.H., Lee, K.O., Effects of Anti-oxidants on Rate of Breakdown of Rubber During Mastication; India Rubber J. (May, 1951)

Cox, W.L., Shelton, J.R., The Effect of Sulfur and Accelerator Variation on Aging; Ind. Eng. Chem., 46:2237 (1954)

Craig, D., Dacidson, W.L., Juve, A.E., Tetramethylthiuram Disulfide Vulcanization of Extracted Rubber: IV. Behavior of Rubber as an Acid; J. Polymer Sci., 6:13 (1951)

Craig, David, Juve, A.E., Davison, W.L., Tetrahethylthiuram Disulfide Vulcanization of Extracted Rubber: I. Introduction and Compounding; J. Polymer Sci., 5:709 (1950)

Craig, D., Davidson, W.L., Juve, A.E., Tetremethylthiuram Disulfide Vulcanization of Extracted Rubber; V. Low Molecular Products and the Mechanism of Zinc Oxide Activation; J. Polymer Sci., 6:2:177 (1951)

Craig, D., Davidson, W.L., Fuve, A.E., Tetramethlthiuram Disulfide Vulcanization of Extracted Rubber: III. Short-Path Distillation of TETD and Its Reaction Rroducts From Rubber; J. Polymer Sci., 6:7 (1951)

Craig, D., Davidson, W.L., Geib, I.G., Juve, A.E., Tetramethylthiuram Disulfide Vulcanization of Extracted Rubber: II. Structure of Radioactive Tetramethylthiuram Disulfide; J. Polymer Sci., 6:1 (1951)

Daly, Lawrence E., Thermoplastic Mixture of Betadiene - Acrylonitrile Rubber, Styrene-Acrylonitrile Resin, and Vinyl Chloride Resin; U.S. 2,924,545 (Feb. 9, 1960)

D'Amico, John J., Leeper, Harold M., Tung, Ching C., Modifying Butyl Rubber with p-Nitroso-aniline Derivatives; U.S. 2,922,780 (Jan. 26, 1960)

Danjard, J.C., Toullec, L., Langlade, A., Le Tourage Au Gras Du Cacutchous Vulcanise, Et La Protection Contre Ce Phenomene; Rev. Gen. Cacutchouc, 35:305 (1958)

Dannenberg, E.M., Seltzer, R.P., A Study of the Aqueous Dispersion Characteristics of Carbon Blacks, Paper Presiented Before ACS Rubber Division Meetings April, 1950, Detroit, Michigan

Dannenberg, E.M., Opie, W.H., Jr., A Study fo the Mositure Adsorption Properties of Carbon Blacks; Rubber World (March, April, 1958)

Dannenberg, E.M., Carbon Black, Dispersion & Reinforcement; Ind. Eng. Chem., 44:813 (1952)

Dannenberg, E.M., Stokes, C.A., Characteristics of Reinforcing Furnace Blacks; Ind. Eng. Chem., 41:812 (1949)

Dannenberg, E.M., Jordan, M.E., Stokes, C.A., Effect of Mechanical Aggregation on the Dispersion Characteristics of Carbon Black; India Rubber World (Sept., 1950)

Dannenberg, E.M., Boonstra, B.B.S.T., Performance of Carbon Blacks, Influence of Surface Roughness and Porosity; Ind. Eng. Chem., 47:339 (1955)

Das, Bejoy Sandar, Choudhury, P.K., Natural Rubber: II. Sol and Gel Rubber; Indian J. Appl. Chem., 22:73 (1959)

Deutsche Gold-und Silber-Scheideanstalt vorm. Roessler, Synthetic Silicates as Rubber Fillers; Ger. 1,035,354 (July 31, 1958)

Deutsche Shell Akt.-Ges. and Metallgesellschaft Akt.-Ges., Synthetic-Rubber Vulcanizates or Reclaims; Ger. 1,077,864 (March 17, 1960)

Dow Chemical Col, Copolymers of Styrenes and Rubber; Ger. 1,040,793 (Oct. 9, 1958)

Dow Corning Corp., Siloxane Elastomers Containing Zinc Oxide or Zinc Peroxide; Ger. 1,033,408 (July 3, 1958)

Dow Corning Corp., Siloxane Elastomers Curing at Room Temperature; Ger. 1,019,462 (Nov. 14, 1957)

Dow Chemical Col, Synthetic Latexes Containing Aliphatic Nitro Alcohols; Brit. 836,335 (June 1, 1960)

Dumonthier, Jean, A Special Filler for Butyl Rubber: Tuboryl; Rev. gen. caoutchouc, 34:469 (1957)

Dunfield, T.E., Watson, W.H., White, F.L., Recent Developments in Synthetic Foam Latex; Rev. Gen. Caoutchouc, 36:86 (1959)

Dunfield, T.E., Watson, W.H., White, F.L., Recent Developments du Latex Synthetique Pour Spongieux; Rev. Gen. Caoutchouc, 36:57 (1959)

Dunlop Rubber Co. Ltd., Adhesives from Betadiene Copolymers and Phenol Condensation Products; Ger. 1,015,166 (Sept. 5, 1957)

Dunlop Rubber Co. Ltd., Bonding Elastomeric Materials to Natural Rubber; Brit. 834,223 (May 4, 1960)

Eby, Lawrence T., Thomas, Robert M., Heat-Reacting Butyl Rubber, Halogenated Butyl Rubber and Zinc Oxide, and Composition Obtained Thereby; U.S. 2,948,700 (Aug. 9,1960)

Eitingon, I.I., Fel'dshtien, M.S., Strel'nikova, N.P., Pevzner, D.M., Vulcanization of Rubber Mixes Having a Synthetic-Rubber or Natural-Rubber Base; U.S.S.R. 124,111 (Nov.20, 1959)

Ernst, John L., Small, Augustus B., Polymerization of Olefins and Diolefins to Synthetic Rubber; U.S. 2,931,791 (Apr. 5, 1960)

Esser, H., Sinn, G., The Reinforcement of Films from Natural and Synthetic Latex with Silica Sols; Kautschuk u. Gummi, 13: WT 126 (1960)

Esso Research and Engineering Co., Brominated Butyl Rubber; Brit. 838,045 (June 22, 1960)

Esso Research and Engineering Co., Brominated Polymeric Elastomers; Brit. 835,639 (May 25, 1960)

Esso Research and Engineering Co., Treatment of Butyl Rubber with Hard Kaolin Clay; Brit. 855,137 (Nov. 30, 1960)

Evaluation of Grades of Mica as Fillers for Latex Foam Rubber; Rev. Gen. Caoutchouc, 36:90 (1959)

Farbenfabriken Bayer Akt.-Ges., Copolymers of 2-Chloro-1,3-Butadiene and Acrylonitrile; Brit. 858,444 (Jan.11, 1961)

Farbenfabrilen Bayer Akt.-Ges., Emulsifiers for the Preparation of Synthetic Rubber; Ger. 1,074,270 (Jan. 28, 1960)

Fekete, Frank, Silicone Elastomer Compositions; U.S. 2,954,357 (Sept. 27, 1960)

Firestone Tire & Rubber Co., Butyl Rubber Compositions Containing Chlorosulfonated Polyethylene; Brit. 836,716 (June 9, 1960)

Firestone Tire & Rubber Co., Polymerization of Butadiene in the Presence of Lithium; Brit. 877,693 (Aug. 6, 1959)

Ford, F.P., Gessler, A.M., Some Properties of Butyl Rubber-Carbon Black Systems; Ind. Eng. Chem., 44:819 (1952)

Ford, F.P., Mottlau, A.Y., Studies in the Dispersion of SRF Carbon Black in Butyl Rubber; Rubber Age (Jan. 1952)

Fore, Sara P., Pastor, H.P., et al, Derivatives of Jojoba Oil as Plasticizers for Vinyl Polymers and Buna-N Rubber; J. Am. Oil Chemists' Soc., 37:287 (1960)

Frank, R.L., Blegan ,J.R., Dautschman, A., Aro Disulfides as Premoter-Modifiers for Copolymerization of Butadiene and Styrene; J. Polymer Sci., 3:58 (1948)

Frank, R.L., Drake, S.S., Smith, P.V.Jr., Stevens, C., Mercaptan Derivatives as Modifiers in the Copolymerization of Butadiene and Styrene; J. Polymer Sci., 3:50 (1948)

Frith, E.M., The Interaction of Plasticisers and Polymers; Trans. Faraday Soc., 41:90 (1945)

General Electric Co., Silicone Rubber; Ger. 1,025,621 (March 6, 1958)

Germon, Wesley M., Compositions of Vinyl Chloride Resins, Copolymers of Betadiene-Acrylonitrile, and a Graft of Butadiene on a Copolymer of Styrene-Acrylonitrile; U.S. 2,927,093 (Mar. 1, 1960)

Gessler, A.B.K.M., Rehner, J., The Reinforcement of Butyl and Other Synthetic Rubbers with Silica Pigments: I. Effect of Heat Treatment; Rubber Age (Sept., 1955)

Gessler, A.M., Wiese, K.H., Rehner, J., The Reinforcement of Butyl and Other Synthetic Rubbers With Silica Pigments: II. Effect of Surface Modification of Silica and Subsequent Heat Treatment; Rubber Age (Oct., 1955)

Gessler, A.M., The Reinforcement of Butyl With Carbon Black: I. Heat Treatment; Methods & Effects; Rubber Age (Oct., 1953)

Gessler, A.M., Ford, F.P., The Reinforcement of Butyl With Carbon Black: III. The Action of Promoting Agents; Rubber Age (Dec., 1953)

Gomory, Paul L., Contact of Materials for Reaction; U.S. 2,951,061 (Aug. 30, 1960)

Goodyear Tire & Rubber Co., Compositions of Vinyl Chloride Resins, Copolymers of Butadiene-Acrylonitrile, and a Graft of Butadiene on a Copolymer of Styrene-Acrylonitrile; Brit. 841,744 (July 20, 1960)

Grisdale, R.O., The Fromation of Carbon Black; J. Appl. Phys., 24:1082 (1963)

Grisdale, R.O., The Properties of Carbon Contacts; J. Appl. Phys., 24:1288 (1953)

Gruber, V.N., Fomicheva, M.M., Mukhina, L.S., Siloxane Rubber; U.S.S.R. 122,874 (Oct. 10, 1959)

Habgood, B.J., Synthetic Rubber; Ann. Rept. Progr. Rubber Technol, 23:29 (1959)

Habgood, B.J., Synthetic Rubber-Production; Ann. Rept. Progr. Rubber Technol, 23:43 (1959)

Hercules Powder Co., Methylolated Rosins in Emulsion Polymerization, Especially of Butadiene and Styrene; Brit. 829,213 (Mar. 2, 1960)

Honn, Francis J., Copolymers of Fluoro Dienes and Styrene; U.S. 2,962,484 (Nov. 29, 1960)

Honn, Francis J., Copolymers of Fluoro Butadienes and Acrylates; U.S. 2,917,496 (Dec. 15, 1959)

Honn, Francis J., Copolymers of Styrene with Fluorinated Dienes; U.S. 2,949,446 (Aug. 16, 1960)

Howland, Louis H., White, Woodrow W., Butadiene Copolymer Rubber-Silica Master-Batch; U.S. 2,964,490 (Dec. 13, 1960)

Hunter, Edward A., Segura, Marnell A., et al, Butyl Rubber Emulsions; U.S. 2,944,038 (July 5, 1960)

Ingridients de Melanges: Accelerateurs de Vulaniation; Rev. Gen. Caoutchouc, 36:66 (1959)

Ingredients de Melanges: Evaluation des Qualites de Mica in Tant Que Charges Pour Mousse de Latex; Rev. Gen. Caoutchouc, 36:64 (1959)

Instytut Przemyslu Skorzanego, Cationic Latex from Synthetic and Natural Resins; Pol. 41,902 (Apr. 30, 1959)

Jankowski, C.J., Powers, K.W., Zapp, R.L., Improved Butyl Rubber Vulcanizates; Rubber Age, 87:833 (1960)

Kaluzhenina, K.F., Ermolaeva, T.A., TiO_2 as Reinforcing Filler for Polysiloxy Rubbers; Trudy Nauch.-Issledovatel. Inst. Rezin. Prom., :42 (1957)

Kekwick, B., et al (Univ, Birmingham, England) Incorporation of DL Mevalonic Acid Lactone C^{16} Into Polyisoprene; Nature 184 Suppl. No. 5, 268 (1959)

Kiriyama, S., Kuraya, T. (Osaka Munic. Univ.) Studies on the Mechanism of Mastication of Rubber: XIII. Absorption Velocity of Oxygen by Various Kinds of Natural Rubber; Nippon Gomu Kyokaishi 30 847 (1957)

Kitchen, L.J., Albert, H.E., Smith, G.E.P.Jr., Alkyl Penols as Nondiscoloring Antioxidants for Synthetic Rubber; Ind. Eng. Chem., 42:675 (April, 1950)

Kirshenbaum, A.D., Hoffman, C.W., Grosse, A.V., Autoradiographic Technique with Carbon 14 in Rubber; Anal. Chem., 23:1440 (1951)

Klebanskii, A.L., Vosik, V.F., Synthesis of Compounds Which are Models of the Basic Types of Synthetic Rubber Structures, and Study of Their Reactivity with Free Radicals; Acta Chim. Acad. Sci. Hung, 21:41 (1959)

Knobloch, Fred W., Hamlin, Horace C., Polymers Derived form Dihydroperfluorobutyl Acrylate; U.S. Govt. Research Repts., 31:159 (1959)

Kolthoff, I.M., Gutmacher, R.G., Determination of Free Carbon in Cured Rubber Stocks; Anal. Chem., 22:1002 (1950)

Kolthoff, I.M., Gutmacher, R.G., Kahn, A., Sorption of GR-S Type Rubber by Carbon Black: II. Effect of Variables on the Sorption by Graphon; J. Phys. & Coloid Chem., 55:1240 (1951)

Kolthoff, I.M., Kahn, The Sorption fo GR-S Type Rubber by Carbon Black: I. Sorption from Benzene Solution by Graphon; J. Phys. & Coloid Chem., 54:251 (1950)

Konkle, G.M., Talcott, T.D., Fluorinated Silicone Rubber Reinforced with Poly(tetra-fluoroethlene); U.S. 2,927,908 (Mar. 8, 1960)

Konkle, G.M., New Developments in Special-Purpose Silicone Polymers: Rubber Age, 84,975 (1959)

Konkle, G.M., Talcott, T.D., Polytetra fluoroethylene-Silicone Compositions; U.S. 2,934,515 (Apr. 26, 1960)

Koppers, Co., Inc., Styrene-Butadiene Rubber Compositions Containing Microcrystalline Waxes; Brit. 832,303 (Apr. 6, 1960)

Kraus, G., Collins, R. (Phillips Petroleum Co., Bartlesville, Okla.), Odd Electrons in Rubber-Reinforcing Carbon Blacks; Rubber World 139:219 (1958)

Kropacheva, E.N., Dolgoplosk, B.A., Kuznetsova, E.M., The Rate of Addition of Ethyllithium to Styrene and Isoprene in the Course of Polymerization; Doklady Akad, Nauk S.S.S.R., 130:1253 (1960)

Kunisawa, Shintaro, Graft-Block Copolymer: IV. Effect of Milling and Heat Polymerization on the Preparation of Natural Rubber-Acrylamide Block Copolymer; Nippon Gomu Kyokaishi, 33:17 (1960)

Kunisawa, Shintaro, Graft-Block Copolymer: III. Natural Rubber-Acrylamide Block Polymer; Nippon Gomu Kyokaishi, 33:16 (1960)

Kunisawa, Shintaro, Graft-Block Copolymer: I. Natural Rubber-Acrylonitrile Graft Copolymer; Nippon Gomu Kyokaishi, 33:5 (1960)

Kunisawa, Shintaro, Graft-Block Copolymer: II. Natural Rubber-Methyl Methacrylate Copolymer; 33:9 (1960) Nippon Gomu Kyokaishi

Kupp, Peter C., Finigan, Charles M., Purification of Butadiene by Using an Ammoniacal Solution of Copper Ions; U.S. 2,944,095 (July 5, 1960)

Kuz'minskii, A.S., Gol'dfarb, Ya.L., et al, Synthesis of Some Thiophene Derivatives and their Properties as Inhibitors of Oxidation and as Accelerators of Vulcanization: II; Zhur. Priklad. Khim., 33:1182 (1960)

Labine, R.A., Flexible Process Makes Silicone Rubber; Chem. Eng., 67:102 (1960)

Lazaryants, E.G., Gromov, V.A., et al, Continuous Ribbon of Butadiene-Styrene Resin; U.S.S.R. 125,375 (Jan. 8, 1960)

Le Bras, J., Danjard, J.C., Boucher, M., Mecanisme de la Protection Par Effet Desactivens; Rev. Gen. Caoutchouc, 34: 787 (1957)

Le Bras, J., Nouvelles Considerations sur les Problemes de Vieillissement du Caoutchouc; Rev. Gen. Caoutchouc, 36:80 (1959)

Lee, K.O., Studies on Mastication; Trans. Inst. Rubber Ind., 31:150 (1955)

Le Foll, J., Mixtures of Neoprene and Hypalon with Other Elastomers and Plastomers; Peintures, pigments vernis 35:370 (1959)

Lo, Elizabeth S., Crawford, Geo. H.Jr., Elastomeric 2-(Trifluoromethyl) Butadiene Copolymers with Fluorinated Hydrocarbons; U.S. 2,951,065 (Aug. 30, 1960)

Louth, G.D., Determination of Free Carbon in Compounded Rubber and Synthetic Elastomers; Anal. Chem., 20:717 (1948)

Lucas, Glennard R., Modified Fillers for Polysiloxane Elastomers; U.S. 2,938,009 (May 24, 1960)

Lyon, F., Burgess, K.A., Sweitzer, C.W., Dual Inhiabition-Acceleration Role of Carbon Black in Rubber Oxidation; Ind. Eng. Chem., 48:1544 (1956)

Lyon, F., Burgess, K.A., Seritzer, C.W., Oxidation of Unvulcanized Rubber, Effect of Carbon Black; Ind. Eng. Chem., 46: 596 (1954)

Maizels, M.G., Raevskii, V.G., Parshina, E.A., Butyl Rubber: I. Principles of Building a Rational Technology of Production of Technical Rubber Products Based on Butyl Rubber; Kauchuk i Rezina, 17:11 (1958)

Maizels, M.G., Raevskii, V.G., Parshins, E.A., Butyl Rubber: Principles of Rational Compounding; Kauchuk i Rezina, 17:3 (1958)

Mark, H.F., Situation Actuelle at Perspectives D'Avneir des Composes Macromoleculaires Synthetiques; Rev. Gen. Caoutchouc; 36:69 (1959)

Martin, B.J.A., Controlling Quality of Compounding Laboratory Rusults; Trans. Inst. Rubber Ind., V.30 no. 3:57 (1954)

Material et Appareillage; Rev. Gen. Caoutchouc, 36:62 (1959)

Merker, Robert L., Acryloyloxyalkylorganodisiloxanes and Elastomers Therefrom; U.S. 2,922,807 (Jan. 26, 1960)

Midland Silicones Ltd., Siloxane Elastomers; Brit. 832,488 (Apr. 13, 1960)

Midland Silicones Ltd., Siloxane Elastomers; Brit. 844,128 (Aug. 10, 1960)

Mikhant'ev, B.I., Raevshii, A.B., Butadiene-Styrene w-Polymer; Kauchuk i Rezina, 18:24 (1959)

Minckler, Leon S., Cottle, Delmer L., Lemiszka, Theodore, Curing of Halogenated Butyl Rubber with Dihydrocarboutin Sulfides; U.S. 2,918,456 (Dec. 22, 1959)

Minoura, Yuji, Synthetic Rubber of Polysulfide Series: I. Formation Reaction of Thiokol A.; Nippon Gomu Kyokaishi, 33:110 (1960)

Mochel, W.E., Salisbury, L.F., Barney, A.L., Coffman, D.D., Mighton, C.J., Elastomers from Fluoroprene; Ind. Eng. Chem., 40:2285 (1948)

Monsanto Chemical C., Modifying Butyl Rubber with p-Nitroso-aniline Derivatives; Brit. 841,530 (July 20, 1960)

Monsanto Chemicals Ltd., Styrene-Rubber Copolymers; Ger. 1,056,373 (Apr. 30, 1959)

"Montecatini" Societa generale per l'industria mineraria e chimica; Polybutadienes; Brit. 849,589 (Sept. 28, 1960)

Morris, R.E., Barrett, A.E., Permanence of Plasticizers in GR-S Vulcanizates Exposed to Weather; Rubber Age (1951)

Neal, A.M., Vincent, J.R., Preserving Rubber — United States Patent Office 2,388,562; E.I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Ninomiya, K. (Univ. Kyoto, Maizuru) Effects of Blending on the Stress-Relaxation Behavior of Poly-Vinyl Acetate in the Rubbery Region; J. Colloid Sci., 14:49 (1959)

Nippon Chemical Fiber Research Foundation, Strengthening Butyl Rubber; Japan 14,781 (Oct. 6, 1960)

Novikova, E., Ermolenko, N., Relation Between Sorption and the Protective Action of Inhibitors in Oxidized Rubbers; Sbornik Nauch. Rabot. Akad. Nauk Balaruss. S.S.S.R. Inst. Khim. 1958 6:133-44

Novy, L.E., Clark, R.A., Compounding Rubbers for Resistance to Silicate-Ester Fluids; I. Neoprene WRT; Rubber Age, (May-June 1957)

Oddoux, J., Donnet, J.B., Laboratory Techniques for Preparing Butadiene Copolymers and Copolymer-Carbon-Black Master Batches; Rev. Gen. Caoutchouc, 35:446 (1958)

Ossefort, Z.T., The Influence of Accelerator Residues on Age Resistance of Elastomeric Vulcanizates; Rock Island Arsenal Lab. Rpt. No. 58-2474

Parker, C.A., Analysis of Accelerators and Anti-Oxidants; J. Roy. Inst. Chem., :674 (Oct., 1957)

Parker, C.A., Berriman, J.M., Chromatographic Analysis of Vulcanized Rubbers; Trans. Inst. Rubber Ind., 28:279 (1952)

Parker, C.A., Berriman, J.M., Chromatographic Analysis of Vulcanized Rubbers; Trans. Inst. Rubber Ind., 30:79 (1954)

Parker, C.A., Chromatography of Rubber Accelerators and Anti-Oxidants on Silica Gel; Nature, 170:539 (1952)

Petrochemicals Ltd., Copolymers of Styrene and Butadiene; Ger. 1,037,135 (Aug. 21, 1958)

Phillips Petroleum C., Blends of Silicone Rubber with Crystalline Polyethylene; Brit. 843,665 (Aug. 10, 1960)

Pierce, O.R., Holbrook, G.W., et al, Fluorosilicone Rubber; Ind. Chem. Eng., 52:783 (1960)

Pike, Roscoe A., Heat-Curable Silicone Elastomers Containing Antioxidants; U.S. 2,953,543 (Sept. 20, 1960)

Placek, Lida L., Pastor, H.P., et al, Divinyl Sulfone-Eleostearate Adducts as Plasticizers for Nitrile Rubber; J. Am. Oil Chemists' Soc., 38:107 (1961)

Placek, Lida L., Pastor, H.P., et al, Tung Oil Derivatives as Plasticizers for Buna-N Rubber; J. Am. Oil Chemists' Soc., 37:307 (1960)

Polmanteer, Keith E., Siloxane Elastomers; U.S. 2,927,907 (Mar. 8, 1960)

Polymer Corp. Ltd., Butadiene-Styrene Latexes of Improved Stability; Ger. 1,039,231 (Sept. 18, 1958)

Polymer Corp. Ltd., Modified Butyl Polymer; Brit. 819,293 (Sept. 2, 1959)

Ponormarev, F.G., Troitskii, A.F., Shatalov, V.P., Unsymmetrical Organic x-Oxides: XIX. Copolymerization of Styrene Oxide with 1,3-Butadiene; Zhur. Priklad. Khim., 33:254 (1960)

Quant, A.J., Dichlorobenzidine as a Curing Agent for Adiprene L-100; U.S. Atomic Energy Comm., SCR-187:14 (1960)

Raamsdonk, G.W. von, Coating of Metals with Latex-Rubber; Rubber J. (Aug., 1955)

Railsback, H.E., New Developments in Cis-Polybutadine Elastomers; Rubber Age, 84:967 (1959)

Rehner, J. Jr., Holowchak, J., Determination of Total and Combined Sulfur in Butyl Rubber; Ind. Eng. Chem., 16:98 (1944)

Rehner, J., Gessler, A.M., The Reinforcement of Butyl with Carbon Black: IV. Effect of Polymer Composition and Molecular Weight on Efficiency of Heat Treatment; Rubber Age (Jan., 1954)

Raamsdonk, G.W. von, Latex-Klebstoffe; Chem. Rundschau (Solothurn), 8:65 (1955)

Reich, M.H., Taft, W.K., Laundrie, R.W., Breakdown of Synthetic Elastomers in a Banbury Mixer with Added Air; Rubber Age, (Oct., 1951)

Reid, Robert J., Conard, Wendell R., Blends of Synthetic Resinous Copolymers with Rubbery Materials; U.S. 2,929,795 (Mar. 22, 1960)

Russell, R.A., Fibrous Silicone Rubber; Ind. Eng. Chem., 52:405 (1960)

Saunders, J. (Mobay Chem. Co., New Martinsville, W.Va.) Reactions of Isocyanates and Isocyanate Derivatives at Elevated Temp.; Rubber Chem. Technol. 32:337 (1959)

Savage, R.M., New Developments in Silicone Rubbers; Rubber Age, 84:972 (1959)

Savage, R.M., Silicone-Rubber Compositions; U.S. 2,938,007 (May 24, 1960)

Schmidt, E., Kelsey, R.H., Creaming Latex with Ammonium Alginate: Influence of Particle Size; Ind. Eng. Chem., 43:406 (1951)

Schneider, Paul, Scriba, Gottfried, Graulich, Wilhelm, Mixtures of Elastomeric Copolymers of Butadiene with Thermoplastic Copolymers of Styrene and Acrylonitrile; U.S. 2,925,399 (Feb. 16, 1960)

Schramm, Charles K., Polypropylene-Butyl Rubber Blends; U.S. 2,939,860 (June 7, 1960)

Seaman, R.G., Carlton, C.A., Available Dry Styrene-Butadiene Rubbers (SBR) - United States and Canada; Rubber World, 140: 421 (1959)

Semegen, S.T., Wahelin, J.H., Studies on the Vulcanization and Structure of Polyacrylic Rubber; Rubber Age, 71: (Apr., 1952)

Serniuk, Geo. E., Aldehyde-Modified Butyl Rubber; U.S. 2,952,657 (Sept. 13, 1960)

Serniuk, Geo. E., Rehner, John Jr., Butyl Rubber Compounded with Radiation-Polymerized Alkanes; U.S. 2,967,138 (Jan. 3, 1961)

Shelton, J.R., Wickham, W.T. Jr., Carbon Black in the Oxidation of Butadiene-Styrene Bulcanizates; Ind. Eng. Chem., 49:1277 (1957)

Shelton, J.R., Wickham, W.T., Effect of Inhibitor Variations in Rubber Vulcanizates; Ind. Eng. Chem., 47:2559 (1955)

Shimosato, Joji, Yasunaga, Hidetoshi, et al, Manufacture of High-Styrene Resin: I.; Nippon Gomu Kyokaishi, 33:87 (1960)

Small, Augustus B., Ernst, John L., High-Molecular-Weight Polyisobutylene; U.S. 2,927,104 (Mar. 1, 1960)

Smirnov, R.N., Mercurated Rubbers: I. Mercurated Butadine Rubbers; Vysokomole Kulyarnye Soedineniya, 2:558 (1960)

Smith, H.S., Werner, H.G., Madigan, J.C., Howland, L.H., GR-S Latex Polymerized at Low Temperatures; Ind. Eng. Chem., 41:1584 (1949)

Smith, J.F., Dithiol Curing Agenst for "Viton" a Fluoroelastomer; Rubber World, 140:263 (1959)

Smith, W.R., Carbon Black; Encyclopedia Chem. Technol., 3:34 (1949)

Smith, W.R., The Behavior of Carbon Black in Rubber and Plastics; India Rubber World, :325 (Dec., 1951)

Societe auxiliaire de l'institut francais du caoutchouc, Foam Rubber; Fr. 1,165,874 (Oct. 30, 1958)

Societe des usines chimiques Rhene-Poulenc, Elastomers Based on Diorganopoly siloxanes; Fr. 1,188,495 (Sept. 23, 1959)

Solvay & Cie, Precipitated Calcium Carbonate; Brit. 831,921 (Apr. 6, 1960)

Stearns, R.S., Forman, L.E., Stereoregular Polymerization of Isoprene with Lithium and Organolithium Compounds; J. Polymer Sci., 41:381 (1959)

Stickney, P.B., Effect of Cure on Low-Temperature and Aging Properties of Nitrile Rubbers; Rubber World, (1956)

Stickney, P.B., Cheyney, L.E., Powers, P.O., Influence of Cloud Points of Coumarone-Indene Resins on Their Use in Rubber Compounding; Ind. Eng. Chem., 40:267 (1948)

Studebaker, M.L., Chemical Forces in Reinforcement of Rubber by Carbon Black; Rubber Age, 77:69 (1955)

Studebaker, M.L., Some Recent Concepts in the Colloid Chemistry of Carbon Black and Its Reinforcement of Rubber; Kautschuk u. Gummi (German), 6:193 (1953)

Sweitzer, C.W., Lyon, F., Oxidation of Unvulcanized Cold Rubber; Influence of Adsorption by Carbon Black; Ind. Eng. Chem., 44:125 (1952)

Sweitzer, C.W., Role of Carbon Structure in the Reinforcement of Rubber; Proc. Inst. Rubber Ind., 2:No3 (1955)

Sweitzer, C.W., Hess, W.M., Callan, J.E., The Despersion of Carbon Black in Rubber and Its Role in Vulcanizate Properties; Rubber World, I.; :869 (Sept., 1958), II. 2:74 (Oct., 1958)

Taylor, R.H., Fielding, J.H., Mooney, M., Development and Standardization of Tests for Evaluating Processibility of Rubber; ASTM Symposium on Rubber Testing, (1947)

Thompson, D.C., Catton, N.L., Weather Resistance of Neoprene Vulcanizates; Effect of Compounding Ingredients; Ind. Eng. Chem., 42:892 (1950)

Tiger, G.J., Reich, M.H., Taft, W.K., Effect of Air on Banbury Breakdown of Low Temperature Polymers; Ind. Eng. Chem., 42:2562 (1950)

Tixier, R.P., Le Latex D'Hevea. Physiologie et Physiopathologie des Conditions de la Production; Rev. Gen. Caoutchouc, 36:73 (1959)

Tobiishi, T., et al (Dunlop Rubber Co1, Kobe) Measurement of Resilience with the Dunlop Tripsometer III. Effect of Compounding Ingredients on the Resilience of Vulcanized Rubber II. Effect of Inorganic Fillers; Nippon Gomu Kyohsishi 31:615 (1958)

Tsyskovskii, V.K., Levina, M.I., Synthesis of Plasticizers from High-Molecular-Weight Acids Containing Isomeric Structures; Khim. Prom., :19 (1959)

Tufts, Edgar, New Developments in Fluoroelastomers; Rubber Age, 84:963 (1959)

Union Carbide Corp., Curing and Forming of Silicone Rubber; Ger. 1,012,069 (July 11, 1957)

Union Carbide Corp., Siloxane Elastomers; Brit. 834,261 (May 4, 1960)

United States Rubber Co., Synthetic Rubber and Leather; Ger. 1,023,219 (Jan. 23, 1958)

Vanderbilt News, Classification of Compounding Materials; 24:4-8 (1958)

Vanderbilt News, Commercial Compounds and Properties; 24:30-56 (1958)

Vanderbilt News, Compound Development; 24:12-29 (1958)

Vanderbilt News, Flow Diagrams for Rubber Goods Manufacture; 24:10-11 (1958)

Vanderbilt News, Introduction to Rubber Compounding; 24:2 (1958)

Vanderbilt News, Major Commercial Rubbers and Properties; 24:3 (1958)

Vanderbilt News, Objectives in Compounding; 24:9 (1958)

Verbanc, J.J., Arnold, R.G., Hypalon, a Chlorosulfonated Polyethylene; Congr., Lucerne, 4:289 (1957)

Vinogradov, P.A., Arseneva, N.G., Gavshinova, K.E., Products from Nitrile Rubbers or from Nitrile Copolymers with Butadiene or with Other Unsaturated Compounds; U.S.S.R. 127,386 (Mar. 25, 1960)

Vinogradov, P.A., Arseneva, N.G., Gavshinova, K.E., Terpolymers of Butadiene, Acrylonitrile, and 2-Methyl-5-Vinylpyridine; Kauchuk i Rezina, 19:5 (1960)

Volkova, N.S., Khutareva, G.V., et al, Synthesis and Investigation of Stereoregular Copolymers of Propylene and Isoprene; Vysokomolekulyarnye Soedineniya, 1:1758 (1959)

Wacker-Chemie G.m.b.h., Organopolysiloxane Elastomers; Ger. 1,058,254 (May 27, 1959)

Wadelin, C.W., Ultraviolet Determination of Phenolic Anti-Oxidants in Rubber; Anal. Chem., 28:1530 (1956)

White, L.M., Ebers, E.S., Shriver, C.E., ObjectiveLaboratory Testing of the Processability of Elastomers; Ind. Eng. Chem., 37:767 (1945)

Wick, M., Boron Siloxane Elastomers; Kunststoffe, 50:433 (1960)

Winn, H., Shelton, J.R., Trunbull, D., Role of Carbon in Oxidation of GR-S Vulcanizates; Ind. Eng. Chem., 38:1052 (1946)

Wolf, Ralph F., Non-Discoloring Promoters of Butyl Rubber-Reinforcing Silica Thermal Interaction; Rubber World, 142:81 (1960)

Yokose, Kyohei, Kakimoto, Hiroshi, Arai, Tetsuo, Behavior of Sulfur in Butyl Rubber; Nippon Gomu Kyokaishi, 32:460 (1959)

Zabotin ,K.P., Morozov, L.A., et al, Continuous Method for Emulsion Copolymerization of Butyl Acrylate with Acrylonitrile; Khim. Prom., :24 (1959)

Zapp, R.L., Stability of the Vulcanized Cross Link in Butyl Rubber: Theory and Application; J. Polymer Sci., 9:97 (1952)

Zapp, R.L., Gessler, A.M., The Reinforcement of Butyl with Carbon Black: II. Specific Action of Surface Oxygen; Rubber Age, (Nov., 1953)

CHEMISTRY OF RUBBER BIBLIOGRAPHY

Amerongen, G. J., von, Koningsberger, C., Cholorination of Natural Rubber. II. Preparation and Properties of Rubber Dichloride; J. Polymer Sci., 5:653 (1950)

Aldridge, Clyde L., Curing Unsaturated Polymers; U. S. 2,962,479 (Nov. 29, 1960)

Aldridge, Clyde L., Charlet, Elphege M., Emulsification of Hydrocarbon Polymers; U. S. 2,933,468 (Apr. 19, 1960)

Anchor Chemical Co., Ltd., Vulcanization of Butyl Rubber; Brit. 835,469 (May 18, 1960)

Arnold, P.M., et al (Phillips Petroleum Co., Bartlesville, Oklahoma). The Vulcanization of Butadiene/Styrene Rubber by Gamma-Radiation, Kautschuk u Gummi. 12;WT 27 - WT 32 (1959)

Baldwin, Francis P., Thomas, Robert M., Chlorinating Butyl Rubber and Vulcanizing the Chlorinated Product; U. S. 2,964,489 (Dec. 13, 1960)

Baldwin, Francis P., Thomas, Robert M., Vulcanization of Chlorinated Butyl Rubber; U. S. 2,926,7k8 (Mar. 1, 1960)

Bateman, L., Glazebrook, R. W., Moore, C. G., The Reaction of Sulfur and Sulfur Compounds with Olefinic Substances. XII. Effects of Vulcanizing Additives on the Reactionof Sulfur with 2,6-Dimothylocta - 2,6-diene, and their Bearing on the Mechanism of Sulfur Vulcanization of Natural Rubber; J. Appl. Polymer Sci., 1:257 (1959

B. F. Goodrich Co., Polyymerizing Substituted Butadienes; Brit. 847,824 (Sept. 14, 1960)

Blanchard, A. F., and Wooton, P. M., (Dunlop Research Center, Birmingham, Engl.), Entangelement and other Steric Effects in Cross-linked Polymers, J. Polymer Sci., 34,627 (1959)

Blease, R. A., Tuckett, R. F., Fractionation and Size Distribution in Vinyl Acetate Polymers, Trans. Faraday Soc., 37:571 (1941)

Bluestein, Ben A., Curing Silica-Containining Organopolysiloxane Elastomers with Amines; U. S. 2,938,010 (May 24, 1960)

Braidwood, Clinton A., Non sulfur Vulcanization of Butyl Rubber; U. S. 2,963,462 (Dec. 6, 1960)

Bresler, S. E., Investigation of the Mechanism of Vulcanization of Rubber with the Help of Radiosulfur; Ricerca sci. 25:923 (1954)

Brodkey, Robert S., Miller, Alfred L., Stabilization of Butyl Rubber Latexes; U. S. 2,955,094 (Oct. 4, 1960)

Brooks, Lester A., Bacon, Jack C., Vulcanization of Neoprene Type W.; U. S. 2,911,392 (Nov. 3, 1959)

Cockbain, E. G., Pendle, T. D., Turner, D. T., Formation of Graft Polymers by 8-Irradiation of Natural - Rubber Latex and Methyl Methacrylate; J. Polymer Sci. 39:419 (1959)

Columbia - Southern Chemical Corp., Curing and Fabricating Butyl Rubber; Brit. 858,125 (Jan. 4, 1961)

Cooper, W., Chemistry of Natural Raw and Vulcanized Rubber; Ann. Rept. Progr. Rubber Technol, 23: 18 (1959)

Cunneen, J. I., Higgins, G. M. C., Watson, W. F., Cis-Trans Isomerization in Polyisoprenes. V. The Isomerization of Natural Rubber, Gutta-Percha, Squalene, Cis-and Trans-3-Methylpent-2-ene, and Cis-poly butadiene, and its Quantitative Estimation; J. Polymer Sci., 40:1 (1959)

Cunneen, J. I., Moore, C. G., Shephard, B. R., New Methods of Cross-linking Natural Rubber. I. The Introduction of Carboxylic Acid and Ester Groups into Natural Rubber and Their Subsequent Utilization for Cross-Linking; J. Appl. Polymer Sci., 3:11 (1960)

Cunneen, J. I., Swift, P. McL., Watson, W. F., Cis-Trans Isomerization in Polyisoprenes. VI. Production of Crystallization-Inhibited Natural Rubber by Treatment with Butadiene Sulfone; Trans. Inst. Rubber Ind., 36:17 (1960)

Devirts E., and Novikov, A. S., Mechanical and Thermo-oxidizing Plastication of Butadiene-Nitrile Rubbers, Kauchuk i Rezina, 18 No. 7, 21, (1958)

Devirts, E., and Novikov, A. S., Effect of Oxidation Reduction Systems on the Oxidative Plastioization of Butadiene-nitrile Rubbers Kauchuk i Rezina, 18, No. 11, 17, (1959)

Dinsmore, R. P., Specifications for a Rubber Chemist, Rubber World, (Apr., 1956)

Dogadkin, B. A., Vulcanizing Structures and Their Change in Curing and in the Thermo-chemical and Fatigue Treatment of the Vulcanizates, Khim Nauka i Prom, 4, 55, (1959)

Dow Corning Corp., Curing for Vulcanizing Organopolysiloxanes; Ger. 1,039,228 (Sept. 18, 1958)

Dow Corning Corp., Vulcanization of Organopolysiloxames Containing Vinyl Groups; Ger. 1,034,355 (July 17, 1958)

Dunham, Milton L., Bitner, Clarence L., Curing Silicone Elastomers; Brit. 821,477 (Oct. 7, 1959)

Dunkel, Walter L., Neu, Robert F., Phelan, Richard R., Surface Curing of Butyl Rubber; U. S. 2,974,113 (Mar. 7, 1961)

Dunlop Rubber Co. Ltd., Curing Elastomeric Copolymers of Butadiene and Alkyl Acrylates; Brit. 851,045 (Oct. 12, 1960)

Edgerley, Peter G., Laville, Jocelyn R., Polymerization or Copolymerization of 1,3-Butadiene; Brit. 822,840 (Nov. 4, 1959)

Eitingon, I. I., Feldshtein, M. S., et al, Vulcanization of Natural and Synthtic Rubbers; U.S.S.R. 127,387 (Mar. 25, 1960)

Elod, Egon, Vulcanization of Synthetic Rubber Containing Carboxyl Groups; Ger. 1059,699 (Apr. 9, 1959)

Esso Research and Engineering Co., Catalytic Halogenation of Butyl Rubber; Brit. 839,270 (June 29, 1960) U. S. 2,948,709 (Aug. 9, 1960)

Esso Research and Engineering Co., Halogenation of Butyl Rubber; Brit, 847,544 (Sept. 7, 1960)

Esso Research and Engineering Co., Polymerization of Olefins and Diolefins to Synthetic Rubber; Ger. 1,046,885 (Dec. 18, 1958)

Esso Research and Engineering Co., Vulcanization of Chlorinated Butyl Rubber; Brit. 829,598 (Mar. 2, 1960)

Esso Research and Engineering Co., Vulcanization of Chlorinated Butyl Rubbers; Brit. 835,505 (May 18, 1960)

Esso Research and Engineering Co., Vulcanizing Brominated Butyl Rubber; Brit. 840,005 (July 6, 1960)

Esso Research and Engineering Co., Vulcanization of Synthetic Rubber with Polyhalomethyl Phenols; Brit. 857,428 (Dec. 29, 1960)

Fanning, H. J., Bekkedahl, N., Quantitative Determination of Natural Rubber Hydrocarbon by Refractive Index Measurements <u>Anal. Chem</u>., 23:1653 (1951)

Farbenfabriken Bayer Akt. - Ges., Curing Catalysts for Natural and Synthetic Rubbers; Ger. 1,050,997 (Feb. 19, 1959)

Farbenfabriken Bayer Akt. - Ges., Polymerization of 2-Chloro-1,3-Butadiene; Ger. 1,040?47 (Oct. 2, 1958)

Farbenfabriken Bayer Akt. - Ges., Sulfur-free Vulcanizigg Agents; Ger. 1,057,104 (May 14, 1959)

Farbenfabriken Bayer Akt. - Ges., Silicone Elastomers; Ger. 1,019,084 (Nov. 7, 1957)

Fischer, D. J., Flegel, V., Vulcanization of Polysiloxances. Accelerated Electrons and High Temperature Ambients; Rubber Age, 88:816 (1961)

Flory, P. J., et al, (Mellon Inst., Pittsburg, Pa.), Influence of Bond Angle Restrictions and Polymer Elasticity, J. Polymer Sci, 34, 337, (1959)

Ford, Francis P., Covulcanized Butyl Rubber with Highly Unsaturated Rubbers by Amino Compounds; U. S. 2,948,320 (Aug. 9, 1960)

Gerlicher, Robert A., Denson, Wm. P., Processing Synthetic Rubber Latex; U. S. 2,927,065 (Mar. 1, 1960)

Gregg, Earl C. Jr., Nonsulfur Curing of Butadiene-Styrene Elastomers; U. S. 2,968,640 (Jan. 17, 1961)

Gupta, S. R. Sen, Natural Elastomers; J. Sci. Club Calcutta, 12:178 (1959)

Gralen, N., Langemaem, G., A Contribution to the Knowledge of Some Physico-Chemical Properties of Polystyrene; J. Phys. Chem., 56:514 (1952)

Hawkins, S. W., Richards, R. B., Light Transmission and the Formation and Decay of Spherulites in Polythere, J. Polymer Sci., 4:515 (1949)

Hilton, Frederick, Reaction Products of Natural and Synthetic Rubbers with Organic Sulfenyl Halides; Brit. 828,319 (Feb. 17, 1960)

Huggins, M. L., Comparisons of the Structures of Stretched Linear Polymers, J. Chem. Phys., 13:37 (1945)

Hunter, B. A., Nawakowski, A. C., Important Quality Factors in Styrene-Butadiene Rubber (SBR) as Affected by Stabilizers and Flocculation Techniques; J. Chem. Eng. Data, 4:355 (1959)

Imperial Chemical Industries Ltd., Vulcanization of Symthetic Rubber; Brit. 841,079 (July 13, 1960)

Janacek, J., Evaluation of Carbon Black in Buna S-3. Chemprumysl 8, 33 No. 2, 97-103 (1958)

Kartsev, V. N., Vulcanization of Synthetic and Natural Rubbers; U.S.S.R. 130,667 (Aug. 5, 1960)

Kheraskova, E. P., Okhapkina, N. A., Provorov, V. N., Determination of Free Sulfur in Rubbers With Sulfur-Containing Accelerators; Zavodskaya Lab., 23:798 (1957)

Klebanskii, A. L., Vosik, V. F., Reactivity of Compounds, which Simulate the Basic Types of Synthetic Rubbers, Towards Free Radicals. I. Interaction with Tert-butoxy Radical; Vysckomole Kulyarnye Soedineniya, 1:1242 (1969) II. Interaction with Diphenylpicrylhydrazyl; Vysckomole Kulyarne Soedineniya, 1:1246 (1959)

Kolthoff, I. M., Lee, T. S., Use of Perbenzoic Acid in Analysis of Unsaturated Compounds. II. Determination of External DoubleBonds in Synthetic Rubbers; J. Polymer Sci. 2:206 (1947)

Kolthoff, I. M., Lee, T. S., Mairs, M. A., Use of Perbenzoid Acid in Analysis of Unsaturated Compounds, I. Preparation and Stability of Solutions of Perbensoic Acid; J. Polymer Sci., 2:199 (1947)

Kolthoff, I. M., Lee, T. S., Mairs, M. A., Use of Perbenzoic Acid in Analysis of Unsaturated Compounds. III. Results of Determinations of External Double Bonds in Synthetic Rubbers, J. Polymer Sci., 2:220 (1947)

Kress, K. E., Absorptiometric Microdetermination of Total Sulfur in Rubber Products; Anal. Chem., 27:1618 (1955)

Kress, K. E., Semimicro Rapid Reflex Method for Solvent Extraction of Rubber Products; Rubber World, :709 (Aug. 1956)

Kress, K. E., Absorptionmetric Determination of Lead in Rubber Products and Compounding Materials; Anal. Chem., 29:803 (1957)

Rubinova, M., (Vyskumny ustav Syntetickeho, Kaucuku, Gottwaldov, Czech.) Isoprene Estimation in Reaction Mixtures, Chem. Prumysl 9 160 (1959)

Lambert, Merlan M., Segura, Marnell A., Hunter, Edward A., Purification of Butyl Rubber Modified with Nitroso Aromatic Compounds; U. S. 2,953,549 (Sept. 20, 19600

Lazaryants, E. G., Gromora, V. A., et al, Polymerization of Synthetic Rubber in Emulsions Stabilized with Rosin Salts; U.S.S.R. 125,679 (Jan. 15, 1960)

Le Beau, D. S., Quantative Estimation of GR-S in Rubber Reclaim, Anal. Chem., 20:355 (Apr. 1948)

LeBras, J., Pinazzi, C., Milbert, G., Modification of Natural Rubber by Reaction with Maleic Anhydride; Rev. gen. caoutchouc, 35:605 (1958)

Linnig, Frederic J., Parks, Edwin J., Wall, Leo A., Reaction of Sulfur, Hydrogen Sulfide, and Accelerators with Propylene and Butadiene; J. Research Natl. Bur. Standards, 65A:79 (1961)

Lee, T. S., Kolthoff, I. M., Johnson, E., Determination of Unsaturation of Butyl Rubbers and Certain Branched Olefins: Anal. Chem., 22:995 (1950)

[illegible]lse, C. L., Determination of Total Sulfur in Rubber; Ind. Eng. Chem., 15:602 (1943)

[illegible]lse, C. L., Determination of Total Sulfur in Rubber; Ind. & Eng. Chem., Anal. Ed., 17:298 (1945)

Ma[illegible]zel[illegible], M. G., Reevskii, V. G., Selection of Optimum Conditions of Vulcanization of Rubber Articles Based on New Synthetic Rubbers; Trudy Nauch.-Issledovatel. Inst. [illegible] Prom., [illegible]34 (1960)

Margolin, Yu., Gersl, M., Ionic Deposition of Butadiene-[illegible] Nitrile Latexes; Kauchuk i Rezina, 17:15 (1958)

Marvel, C. S., The Structure of Butadiene-Styrene Type Copolymers. The Butadiene-o-Chlorostyrene Copolymer, J. Am. Chem. Soc., 72:3889 (1950)

Medalia, A. I., Kolthoff, I. M., Determination of Microgel in GR-S Rubber, J. Polymer Sci [illegible]:433 (195[illegible])

Merrett, Frank M., Separation and Characterization of Graft Copolymers from Natural Rubber; Rubber Chem. Tech., 31:818 (1958)

Meyrick, T. J., Watts, J. T., Polyisocyanates in Bonding; Trans. Inst. Rubber Ind., 25:150 (1949)

Meyrick, T. J., Watts J. T., Polyisocyanates in Bonding "Terylene" Polyester Fiber to Rubber; India Rubber J., Mar, (1952)

Milliken, Lewis T., Linnig, Frederic J., Interference of Antioxidant in the Determination of Low Polymer in SBR Synthetic Rubber; J. Polymer Sci., 41:544 1959)

Minckler, Leon S. Jr., Cottle, Delmer L., Eby, Lawrence T., Compositions Comprising Halogenated Butyl Rubber and Comminuted Metal and their Vulcanization: U. S. 2,941,975 (June 21, 1960)

Monsanto Chemicals Ltd., Graft Polymerization, Especially of Styrene on a Styrene-Butadiene Copolymer; Brit. 847,602 (Sept. 7, 1960)

Mori, Yayoi, Sato, Katsuo, Minoura, Yuji, Polymerization of Methyl Methacrylate in the Presence of Natural Rubber; Kogyo Kagaku Zasshi. 61:462 (1958)

Novikov, A. S., Kaluzhenina, K. F., Nudel'man, Z. N., Cold (Room-Temperature) Vulcanization of Organosilicon Rubbers, I. Production of SKT Rubbers by Cold Vulcanization and their Properties; Kauchuk i Rezina, 18:16 (1959)

Novikov, A. S., Nudelman, Z. N., Vulcanization of Organosilicon Rubber; U.S.S.R. 128,461 (May 15, 1960)

O'Conner, F. M., Mays R. L., Chemical-Loaded Molecular Sieves as Latent Curing Aids. A Resin Curing System for Butyl Rubber; I. Chem. Eng. Data, 5:491 (1960)

Oddoux, J., Donnet, J. B., Drying of SBR-Type Polymers; Rev. gen. Caoutchouc, 35:615 (1958)

Osthoff, R. C., Bueche, A. M., Grubb, W. T., Chemical Stress-Relaxatior of Polydimethysiloxane Elastomers, J. Am. Chem. Soc., 76:4659 (1954)

Powers, Kenneth W., Robison, Samuel B., Fusco, James V., Vulcanization of Butyl Rubber; U. S. 2,977,344 (Mar. 28, 1961)

Revertex Ltd., Vulcanization of Natural Rubber; Ber. 1,031,506 (June 4, 1958)

Romanovsky, Cyril, Jordan, Thomas E., Butadiene Catalysts; U. S. 2,920,049 (Jan. 5, 1960)

Rysanek, Antonin, Preparation of Concentrated Synthetic Latexes; Chem. Prumsyl, 10:100 (1960)

Safford, Moyer M., Meyers Robert L., Curing of Polyethylene-Polybutadiene Blends with High-Energy, Ionizing Radiation; U. S. 2,924,559 (Feb. 9, 1960)

Scheele, W., Schluter, C., The Vulcanization of Elastomers. XXXII. Vulcanization of Natural Rubber with Sulfur in the Presence of Dithiocarbamates; Kautschak u. Bummi, 13:WT 387 (1960)

Schultz, E. F., An Improved Water Extraction Test for Polyvinyl Chloride Elastomers, ASTA Bulletin No. 183 (Jul. 1952)

Shatalov, V. P., Popova, E. N., et al, Increasing the stability of the Polymerization System of SKS-30; Kauchuk i Rezina, 19:3 (1960)

Shatalov, V. P., Popova, E. N., et al, Synthesis of Diisopropylbenzene Hydroperoxide and Testing its Initiating Properties in the Butadiene-Styrene SKS-30A Rubber Production Process; Khim. Prom., :13 (1959)

Shimasato, Joji, VI. Studies on Scission Reaction of Cross-Linking by Using Model Compounds; Nippon Gomu Kyakaishi, 32:452 (1959)

Shimosato, J., and Yokata, S. (Nippon Rubber Co., Kurume City, Japan) Vulcanization Accelerators: IV. Mechanism of Thiol and Disulfide Type Acceleration and of Non-Sulfur Vulcanization; VII. Vulcanization with Various Accelertors Followed by Estimation of Zinc Sulfide; Nippon Gomu Kyokaishi 32 423 (1959)

Salomon, G., Brussel, E. P. Van, Schee, A. C. Van Den, Estimation of Rubber in Asphalt; Anal. Chem., 26:1325 (1954)

Small, Augustus B., Polymerization of Butyl Rubber in Solution; U. S. 2,927,912 (Mar. 8, 1960)

Smirnov, R. N., Mercurated Rubbers. II. Reaction of Mercury Derivatives of Butadiene Rubbers with p-Nitrobenzoyl Chloride; Vysokomole Kulyarnye Soedineniya, 2:679 (1960)

Spath, W., Vulcanization as a Statistical Problem, Gummi u. Asbest. 12 706: 792 (1959): 13 228 (1960)

Smith, John F., Curing Fluoroelastomers; U. S. 2,955,104 (Oct. 4, 1960)

Spurr, R. A., Erath, E. H., Myers, H., Pease, D. C., Curing Process in Phenolic Resin; Ind. Eng. Chem, 49L1838 (1957)

Stefanescu, D., Nicolau, C., Gard, Eugenie, Nydrochlorination of Natural Rubber Dissolved Under the Effect of Ionizing Radiation; Proc. U. N. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 29:254 (1958)

Sweitzer, C., et al (Columbian Carbon Co., New York, N.Y.) Dispersion of Carbon Black in Rubber and its Role in Vulcanizate Properties, Rubber World 138 869 (1958); 139 74 (1958)

Szurrat, J., Production and Applications of Silieone Rubber Vulcanizates; Gummi u. Asbest, 12:713 (1959)

Tamney, P. O., Little, J. R., Viohl, Paul, Vulcanization of Butyl Rubber with Phenol-Formaldehyde Derivatives; Ind. Eng. Chem., 51:937 (1959)

Thiokol Chemical Corp., A Study of Butyl Solvent and Chemical Resistance; Thiolol Bulletin 102 (Mar. 1957)

Titov, A. P., Shulman, M. L., Reagent for Emulsion Polymerization of Synthetic Rubber; U.S.S.R. 132,804 (Oct. 20, 1960)

Tkac, A., Kello, V., Mean Life of Free Radicals in Solid Natural Rubber; Trans. Faraday Soc., 55:1211 (1959)

Tsvetkov, A. I., Grinberg, A. R., et al, Plasticizing Natural Rubber; U.S.S.R. 132,801 (Oct. 20, 1960)

United States Rubber Co., Vulcanization of Butyl Rubber; Brit. 826,092 (Dec. 23, 1959)

Ushio. H., and Yoshikawa, M. (Hitachi Densen Co., Hitachi City) Vulcanization Characteristics of Neoprene. Nippon Gomu Kyokaishi 31 276 (1958)

Vaclavek, Vladimir, Molecular-Weight Regulation in the Emulsion Copolymerization of Butadiene with Styrene; Chem. Prumysl, 10:103 (1960)

Vinitskii, L. E., Details of the Vulcanization of Unadulterated Mixtures from SKMS-30 Rubber; Izvest. Vysshikh Ucheb. Zavedenii, Khim. i Khim. Tekhnol, 3:182 (1960)

Volodin, V., and Kuvshinskii, E., Effect of Vulcanization on the Dielectric Properties of an Elastomer Based on SKS-30A Resin, Soviet Phys.-Tech. Phys. 3 1321 (1958)

Votinov, M. P., Subbotin, S. A., et al, A Study of the Crystallizability of Li Isoprene Vulcanizates "SKI" by the Adiabatic Stretching Method; Vysokomolehulyarnye Socdineniya, 1:1016 (1959)

Wacker-Chemic G. m. b. H., Cold Vulcanization of Silcone-Rubber Laminates; Ger. 1,026,520 (Mar. 20, 1958)

Wagner, Melvin Peter, Interaction of Fillers with Styrene-Butadiene Rubber; Univ. Microfilms, L. C. Card, Mic 60-5632:199, Dissertation Abstr. 21:2132 (1961)

Wake, W. (Res. Assoon. Brit. Rubber Mfrs. Shawbury, Engl.) Surface Chemistry and Adhesion of Polymers, Trans. Inst. Rubber Ind. 35 145 (1959)

Watson, J., and Jervis, R. (Dunlop Rubber C., Ltd., Birmingham Engl.) The Significance of Free Radicals for Reinforcement, Kautschuk u. Gummi 12 WT 11-2, 14-16, 18, 20 (1959)

Watson, Wm. B., Butyl Rubber Plasticized with Crude-Oil Fractions; U. S. 2,959,560 (Nov. 8, 1960)

Yurzhenko, T. I., Puchin, V. A., et al, Polymerization Initiator for Synthetic Rubber; U.S.S.R. 128,607 (May 15, 1960)

Yanko, J. A., Physical Properties of Fractions of GR-S and Their Vulcanizates, J. Polymer Sci., 3:576 (1958)

Zakharov, N. D., Porochin, Bv V., Sulfurless Vulcanization of Synthetic Rubbers. II. Curing of ~~Nitrile~~-Butadiene Rubbers with the Use of Some Metal Chlorides; Kauchuki Rezina, 18:14 (1959)

Zakharov, N. D., Shiryaev, B. A., Nonsulfur Valcanization of Some Synthetic Rubbers. I. Thermal Vulcanization of Butadiene-Nitrile Rubbers; Kauchuk i Rezina, 17:11 (1958)

Zanemonets, N., And Fogel, V. (M. Lomonosov Inst. Fin. Chem.-Technol., Moscow) New Method of Determining the Heat Effects of the Vulcanization Reaction of Rubbers, Izvest. Vyssh. Ucheb. Zave., Khim i Khim Tekh. 2 No. 3, 437 (1959)

Zeppernick, F., Breakdown Procedures for the Production of Greatly Broken Down Rubber Compounds. The Breakdown Behavior of Styrene-Butadiene Rubber; Kautschuk u. Gummi, 14:WT 37 (1960)

Zverev, M. P., Zubov, P. I., Interaction of Plasticizers with Fillers; Kolloid. Zhur., 22:756 (1960)

TEMPERATURE BIBLIOGRAPHY

Amerongen, G. J. Van, Oxidative and Nonoxidative Thermal Degradation of Rubber; Ind. Eng. Chem., 47:2565 (1955)

Ball, J. M., Bradley, C. E., J.r, The Effect of Temperature on the Sunlight Deterioration of a Rubber Compound; Rubber Age, 50:425 (1942)

Barlow, Red. W., Cretney, Robert W., Effect of Carbon Black on Rubbers for Low-Temperature Use; Rubber Age, (85:82) (1959)

Bersch, C. F., Harvey, H. R., Archhammer, B. G., Heat and Ultraviolet Aging of Poly(Vinylchloride); J. Research Nat. Bur. Standards, 60:481 (1958)

Bielstein, G., Some Aspects of High-Temperature Vulcanization; Trans. Inst. Rubber Ind., 36:29 (1960)

Bobear, W. J., Behavior of Silicone Rubber in Sealed Systems at High Temperatures; Rubber Age, 84:448 (1958)
Boonstra, B. S. T. T., Tensile Properties of Natural & synthetic Rubbers at Elevated & Subnormal Temperatures; India Rubber World, 121:290 (1949)

Boxser, H., Cashion, C. G., Doner, S. R., Howlett, R. M., Juve, A. E., McCarthy, D., McWhorter, J. F., Readhard, D. F. Jr., The Effect of Air Circulation by Convection in the Test Tube Method of High-Temperature Aging of Synthetic Rubbers; ASTM Bulletin, (Aug. 1947)

Bradbury, E. J., Clark, R. A., Aluminum Block Heater for Aging Rubber and Rubber Compounds at High Temperatures; Rubber World, (Sep. 1956)

Clark, R. A., Gillen, W. H., Development of Magnesia-Loaded Nitrile Rubber Composition for High-Temperature Oil Resistance; Rubber World, (May, 1957)

Clark, Frederick E., (North Am. Aviation Inc., Los Angeles, Calif.) High Temperature Problems Associated with the Use of Rubber in Aircraft, S.A.E. Trans., 64:24 (1956)

Clews, C. J. B., The Crystal Structure of Conjugated Hydrocarbons at Low Temperatures; Trans. Faraday Soc., 36:749 (1940)

Dannis, Mark L., B. F. Goodrich Polymer Co., Brecksville, Ohio) Thermal Expansion Measurements and Transition Temperatures, 1st and 2nd Order, J. Appl. Polymer Sci., 1:121 (1959)

Dannis, Mark L., Thermal Expansion Measurements and Transition Temperatures. II. An Automatic Recording System; J. Appl. Polymer Sci., 4:249 (1960)

Dick, Willie, Muller, F. H., Calorimetric Measurements of the Thermal Effects Involved in the Stretching of Rubber; Kolloid-Z., 172:1 (1960)

Dillon, J. H., Prettyman, I. B., The Effects of Temperature and Humidity on All Physical Properties of Tire Cords; J. Appl. Phys., 16:159 (1945)

Eccher, S., Oberto, S., Improvements in Artificial Aging Ovens; Trans. Inst. Rubber Ind., 27:325 (1951)

Edwards, D. C., Storey, E. B., The Heat-Treatment of Butyl-Carbon Black Compounds; Rubber Chem. Technol., 30:122 (1957)

Esso Research and Engineering Co., Heat-Treated Compositions of Butyl Rubber and Alkeenylhalosilane-Modified Silica; Brit. 823,279 (Nov. 11, 1959)

Fajfar, Miroslav, Jirasek, Karol, Increasing the Heat and Fungus Resistance of Vulcanized Rubber; Czech. 92,727 (Nov. 15, 1959)

Fromandi, G., Reissinger, S., High-Temperatures Mixing of Rubber.II. The Effect of Mixing Temperature and Order of Adding the Ingredients with Various Accelerators on the Properties of the Mixtures and of their Vulcanizates; Kautschuk u. Gummi, 13:WT225 (1960)

Gehman, S. D., Jones, P. J., Wilkinson, C. S. Jr., Woodford, D. E., Low Temperature Stiffening of Elastomers; Ind. Eng. Chem. 42:475 (1950)

Gessler, Albert M., Wiese, Herbert K., Rehner, John Jr., Heat-Treated Composition of Butyl Rubber and Alkenylhalosilane-Modified Silica; U.S. 2,906,722 (Sept. 29, 1959)

Gregory, J. B., Effect of Temperature on the Air Permeability of Silicone Rubber; Rubber World, (Dec, 1955)

Gul, V. E., et al. (Inst. Fini Chem. Technol., Moscow) Study of the Fracture Process in the Transition Range Between the Elastic and the Brittle State, Kolloid Zhur, 20:318 (1958)

Hanok, M., et al, (N. York Naval Shipyard, Brooklyn) A Comparison of Instruments Used to Determine Suitability of Elastomers for Low Temperature Service. II. Stress Decay, Rubber Age, N. Y., 82: 275 (1957)

Hanok, M., et al (N. York Naval Shipyard, Brooklyn) Comparison of Instruments Used to Determine the Suitability of Elastomers for Low Temp. Service; Rubber Age, 81:100 (1957)

Harrington, Robert, How Hot Water Affects Elastomers; Rubber Age, 84:798 (1959)

Harrison, S. R., Cole, O. D., Time-Temperature Relations in Oven Aging of GR-S; Ind. Eng. Chem., 36:702 (1944)

Hayes, Robert A., High-Temperature Tensile Properties of Elastomers Containing Carboxyl Groups; J. Chem. Eng. Data, 5:63 (1960)

Iwasaki, ..., Aoki, M., Kojima, R., The Structural Changes Produced by the Heat Treatment of Polytrifluorochloroethylene; J. Polymer Sci., 25:377 (1957)

Jones, H. C., Synder, E. G., Further Studeis on the Effect of Temperature on the Resilience of Natural and Synthetic Rubber; India Rubber World, 110:Jul. 1944

Juve, A. E., Sckoch, M. G., Jr., The Effect of Temperature on the Air Aging of Rubber Vulcanizates; No Official Pulication

Juve, A. E., Schoch, M. G. Jr., The Effect of Temperature on the Air Aging of Rubber Vulcanizates; ASTM Bulletin No. 195 (Jan. 1954)

Juve, A. E., Shearer, R., Migration Effectsx in Oven Aging; India Rubber World, (Aug 1953)

Konkle, G. ..., McIntyre, J. T., Fenner, J. V., The Effect of High Temperature on the Properties of Organic and Silicone Rubbers; Rubber Age, 79 (June, 1946)

Kruse, J., and Timm, T., Temperature Dependence of the Mechanical and Photoelastic Behavior of Elastomers, Kautschuk u Gummi, 12:WT83 (1959)

Lavery, F., Grover, F. S., Smith, S., Kitchen, L. J., Smith, S., Equipment for High-Temperature Testing; Rubber Age, (Feb, 1957)

Mac-Rae, D., and Sapp, R. (Enjay Labs, Linden, J. J.) Thermal Diffusivity of Butyl Rubber and its Compounds I. Determination of Diffusivity Coefficients, Rubber Age, 82:831 (1958)

MacRae, Donald R., Zapp. R. L., Thermal Diffusivity of Butyl Rubber and its Compounds, II. Application of Diffusivity Coefficients; Rubber Age 82;1024 (1958)

Maynard, J. T., Mochel, W. E., The Structure of Neoprene. VIII Effect of Polymerization Temperature on Polymer Properties; J. Polymer Sci., 18:227 (1955)

Madorsky, S. L., Straus, S., Thermal Degradation of Polymers as a Function of Molecular Structure; J. Research Nat. Bur. Standards, 53:361 (1954)

McCarthy, G. D., Juve, A. E., Boxser, H., Sanger, M., Doner, N., Cunningham, E. N., McWhorter, J. F., Crossley, R. H., High Temperature Oven Aging of Oil-Resisting Synthetic Rubber Compounds; ASTM Bulletin, No. 132 (Jan. 1945)

Mandelkern, L., The Dependence of the Melting Temperature of Bulk Homopolymers on the Crystallization Temperature; J. Polymer Sci., 47:494 (1960)

Marei, A. I., The Effect of Functional Groups on the Glass Transition Temperature of Rubber-like Polymers; Kauchuk i Rezina, 19:1 (1960)

Martin, James Grubb, Neu, R. F., Temperature Coefficient of Vulcanization of Butyl Rubber; Rubber Age, 86:825 (1960)

Mesrobiam, R. B., Tobolsky, A. V., Effect of Chemical Agents on Heat Deterioration of GR-S; Ind. Eng. Chem., 41:1496 (1946)

Momin, A. U., Shankar, U., Suryanarayana, N. P., Improvement of Thermal Conductivity of Chemically Resistant Rubbers; Thermalconductivity Measurements; J. Sci. & Ind. Research, 19A:215 (1960)

Muller, F. (Univ. Marburg, Lahn, Germany) Calorimetric Measurements of Heat Effects Accompanying Rubber Deformation, Kautschuk u. Gummi, 12:WT55 (1958)

Oakes, W. G., Richards, R. B., The Thermal Degradation of Ethylene Polymers; J. Am. Chem. Soc., 619:2929 (1949)

Payne, A. (Research Assocn. Brit. Rubber Manufgs. Schrewsbury, Engl and) Mechanical and Dielectric Temperature Frequency Equivalence of Polymers, SBR, Soc. Chem. Ind. (LONDON) Monograph 5, 273-89

Pedersen, H. L., Relation Between Stress Relaxation and Aging Resistance of Rubber Vulcanizates. II. Effect of Copper in Various Accelerated Stocks; J. Polymer Sci., 10:449 (1953)

Phillips Petroleum Co., Thermal Vulcanization of Polymers of 1, 3-Butadiene; Brit. 828,328 (Feb. 17, 1960)

Polymer Corp. Ltd., Catalyst Injection in Low-Temperature Polymerization Especially in the Manufacture of Butyl Rubber; Brit. 828,536-7 (Feb 17, 1960)

Roberts, D. E., Mandelkern, L., Melting Temperature of Natural-Rubber Networks; J. Am. Chem. Soc., 82:1091 (1960)

School, A. W., Liska, J. W., A Method of Measuring "Heat Embrittlement" of GR-S and Heavier Rubber Compound; India Rubber World, (Feb. 1947)

Schulz, E. F., Effect of Temperature and Composition Upon the Resilience of Elastomers; Modern Plastics, (Aug. 1952)

Shelton, J. R., Wherley, F. J., Cox, W. L., Effect of Temperature Upon Rate of Oxidation of Rubber; Ind. Eng. Chem., 45:2080 (1953)

Shelton, J. R., Winn, H., Oven and Bomb Aging of GR-S at Corresponding Temperatures; Ind. Eng. Chem., 39:1133 (1947)

Smith, Thor L., Stedry, Paul J., Time and Temperature Dependence of the Ultimate Properties of an SBR Rubber at Constant Elongations; J. Appl. Phys., 31:1892 (1960)

Straus, S., Madorsky, S. L., Thermal Degradation of Unvulcanized and Vulcanized Rubber in a Vacuum; Ind. Eng. Chem., 48:1212 (1956)

Straus, S., Madorsky, S. L., Thermal Degradation of Polyacrylonitrile, Polybutadiene, and Copolymers of Butadiene with Acrylonitrile and Styrene; J. Research Nat. Bur. Standards, 61:77 (1958)

Tarasova, Z. N., Fedorova, T. V., Dogadkin, B. A., The Effect of Vulcanization Temperature on the Structure and Properties of Styrene-Butadiene and Isoprene Rubber Vulcanizates; Kauchuk i Rezina, 18:7 (1959)

Trick, G. S., Simplified Method for Determining the Glass Transition Temperature of Elastomers; J. Appl. Polymer Sci., 3:253 (1960)

Umminger, O., Low-Temperature Test Methods for High Polymers; Kautschuk u. Gummi, 14:WT1 (1961)

Voom, M., and Hermans, J. (Univ. Leiden, Netherlands) Wandering of Cross-Links in Rubber at High Temperatures, J. Polymer Sci., 35:113 (1959)

Voorn, M. J., Hermans, J. J., Wandering of Crossliners in Rubber at High Temperatures; J. Polymer Sci., 35:113 (1959)

Williams, G. E, Behavior of Natural and Synthetic Rubbers at High Temperature; Proc. Inst. Rubber Ind., Paper read before London Section, May, 1956

Witte, R. S., Anthony, R. L., Stress-Temperature Studies of Transitions in Rubbers; J. Appl. Phys., 22:639 (1951)

RUBBER IN ENGINEERING BIBLIOGRAPHY

Alligor, G., Willis, J. M., Smith, W. A., Allen, J. J., The Properties and Applications of Coral Rubber -- a Cis 1,4 Polyisoprene; Rubber World, (Jul. 1956)

Andersen, D. E., Arnold, R. O., Aging Stability of Neoprene Latex; Ind. Eng. Chem., 45:2727 (1953)

Andersen, D. E., Kovacic, P., Aging Stability of Neoprene Latex; Relation Between Crosslinking and Hydrolysis of Allylic Chlorine, Ind. Eng. Chem., 47:161 1955

ASTM' The Applications of Synthetic Rubbers, Rymposium on; March, 1944

Ball, J. M., Randal, Rl L., The Effect of Whole Tire Reclaimed Rubber on the Accelerated Aging of Natural Rubber and CR-s; Rubber Age., (March, 1949)

Barnhart, R. R., Calwardy, W. E., Paracril: Paracril Ozo for Ozone Resistance and Nill Resistance; Bulletin #219, Naugatuck Chem.,

Bekkedahl, N. Natural and Synthetic Rubbers; Anal. Chem., 22:253 (1950)

Bekkedahl, N., Natural and Synthetic Rubbers; Anal. Chem., 24:279 (1952)

Bekkedahl, N., Natural and Synthetic Rubbers; Anal. Chem., 25:54, (1953)

Bekkedahl, N., Steinler, R. D., Natural and Synthetic Rubbers; Anal. Chem., 21:266 (1955)

Bekkedahl, N., Tryon, M., Natural and Synthetic Rubbers; Anal. Chem., 27:589 (1955)

Bestul, A. R., Belcher, H. V., Degradation of Polyisobutylenes on Shearing in Solution; J. Appl. Phys., 24:1011 (1953)

Biggs, B. S., Aging of Polyethylene; Nat. Bur. Standards, U.S. Circ. 525 (1953)

Braber, P., Raamsconk, G. W. von, The coagulants-Casting Pro- cess for the Manufacture of Hollow Articles from Natural Rubber Latex; Indonesian J. Nat. Sci., (Jan-June, 1954)

Braendle, H. A., Wiegand, W. B., GR-S, An Elastically Inverted Polymer; Indiea Rubber World, (may 1944)

Braley, S. A., Jr., Properties and Applications of Silicone Rubber Paper given at semi-annual meeting ASME, June, 1956, Cleveland, Ohio

Bueche, A. M., The Curing of Silicone-Rubber with Benzoyl Peroxide; J. Polymer Sci., 15:105 (1955)

Bueche, F., Tensile Strength of Filled Gr-S Vulcanizates; J. Polymer Sci., 33:259 (1953)

Clark, R. A., Rubber for Unusual Applications; Battelle Tech Rev., (Dec. 1955)

Clinebell, B. J., O-Rings -- An annotated Bibliography; India Rubber World (Oct. 1952)

Connecticut Hard Rubber Co., High Temperature Testing of Silicone Rubber; (May, 1958)

Cook, L., Straka, L. E., Engineering Developments of Rubber, Sept. 1954 - Aug. 1955. Duplication of Nat. Rubber, No Official Publication.

Cutting, E. I., Paracril: Paracril Alt. A Low Acrylonitrile, Low Temperature, Polymerized Paracril; Bulletin #229 Naugatuck Chem.

Deasy, J. J., White, B. B., Compounding Silicone Rubber for Minimum Shrinkage; Rubber Age., (Mar. 1957)

DeFrancesco, A. J., Alling, R. D., Baldrige, J. H., Compounding of Silicone Rubber. IV. Testing of Silicone Rubber at Elevated Temperatures; Rubber World, Sept. 1956

Dellaria, J., Outlook for 600 Deg Silicone Rubber; Aviation Age June, 1958

Dow Corning Corp., Characterisitics of Silicone Elastomers; Dow Corning Corp. Pub.

Dow-Corning Corp., Down-Corning Silicone Notes

Fuller, B. W., Where to Use Hypalon: Materials & Methods, (Jan. 1957)

Galwardy, W. E., Paracril Nitrile Rubbers: Standard Grades Characteristics and Compounding; Tech. Bulletin #1, Naugatuck Chem.

Galwardy, W. E., Paracril Nitrile Rubbers: Resistance to Solvents, Ruels, Oils, & Chemicals; Tech Bulletin #2, Naugatuck Chem.

Galwardy, W. E., Paracril Nitrile Rubbers: Resistance to Solvents, Fuels, Oils, & Chemical; Tech. Bulletin #2, Naugatuck Chem.

Gee, G., Tensile Strengths of Pur Gum Natural Rubber Compounds; J. Polymer Sci., 2:451 (1947)

Gehman, S. D., Creep, Recovery, and Permanent Set for GR-S and Hevea; J. Appl. Phys., (1948) 19:456

Goodrich Chemical Co., Hycar Rubber and Latex; Goodrich Chemical Co., Pub.

Goodrich Chemical Co., A Comparative Evaluation of Hycar. Polymers Manual HM-1 (Aug. 1953)

Goodrich Chemical Company, Malving Cements with Hycar Rubber; Manual HN-4 (June, 1959)

Goodyear Tire and Rubber Company, Chemigum N3. Intermediate Acrylonitrite Copolymer for Extrusion-Calendering-Moldins; Tech-Book Facts, (1958)

Gregory, J. B., Silicone Rubber - A Literature Review; Rubber Age, (Nov. 1951)

Gregory, J. B., Effect of Temperature on the Air Permeability of Silicone Rubber; Rubber World, (Dec, 1955)

Harris, T. H., Stiehler, R. D., The Aging of GR-S A Review of the Literature; India Rubber World, (June 1948)

Hauser, E. A., Morphological Studies of Silicone Rubbers; Rubber Age, (Oct. 1954)

Jedlicka, Helmut, Silicone Rubber as Bonding Material; Ger. 1,016,391 (Sept 26, 1957)

Keen, W. N., Creep of Neoprene in Shear Under Static Conditions, Ten Years; Trans. Am Soc. Mech. Eng., (Jul. 1951)

Kilbourne, M. L., Doede, C. M., Stasiumas, K. J., Compounding of Silicone Rubber; Rubber World, (May 1955)

Kilbourne, F. L., Kidwell, A. S., Moroney, T. S., Selecting Silicone Rubbers; Materials & Methods (May 1957)

Kilbourne, F. L., Kidwell, A. S., Moroney, T. S., Selecting Silicones Rubbers. I. Fundamentals and Commerical Types; Materials & Methods, (May 1956)

Kilbourne, F. L., Kidwell, A. S., Moroney, T. S., 1957-Silicone Rubber: I. The Chemistry of Silicone Ruber: II. The Properties of Silicone Rubber: III. The Design of Silicone Rubber Compounds from an Application and Fabrication Standpoint; Conn. Hard Rubber

Konkle, G. M., Selfridge, R. R., Servais, P. C., Behavior of Silastic of Aging; Ind. Eng. Chem., 39:1410 (1947)

Konkle, G. M., New Developments in Silicone Rubber; Paper given at semipannual meeting ASME, June, 1958, Detroit, Michigan.

Kuckro, C. W., Womack, H., Hycar 2202, General Properties and Electrical Characteristics; Tech. Beull. No official pub.

Lichty, J. G., Spacht, R. B., Hollingshead, W. S., Evaluation of Commercial GR-S Vulcanizates by a Creep Test; Ind. Eng. Chem. 47:165 (1955)

Liska, J. W., Low-Temperature Properties of Elastomers; ASTM Spec. Tech. Pub. 78

Mayo, L. R., Griffin, R. S., Keen, W.N., Accelerated Aging of neoprene Compounds - Effect of Copper; Ind. Eng. Chem, 40:1977 (1948)

Monack, A. J., Electrical Insulation Materials; Material & Methods, manual No. 137 (April 1957)

Morgan, Coleman P., Meltz, Robert R., Oil-Resistant, Electrically Insulating Butadiene-Acrylonitrile Rubber containing Magnesia; U.S. 2,933,466 (Apr. 19, 1960)

Neal, A. M., Ottenhoff, P., GR-S Vulcanizates - Resistance to Various Type of Aging; Ind. Eng. Chem, 36:552 (1944)

Neoprene Notebook, Accelerated Aging vs. Long Terms Aging; No. 34 (1945)

Noad, R. B., Silicone Rubbers; Proc. Inst. Rubber Ind., 1:116 (1954)

Peizner, A. B., Uzina, R. V., et al, Basic Factors Governing the Type of Butadiene-Styrene Latex in Solutioning Tire Cord; Kauchuk i Rezina, 18:10 (1959)

Polmanteer, K. E., Servais, P. C., Konkle, G. M., Elasticity at Low Temperature Behavior of Silicone and Organic Rubbers at -130° F.Low; Ind. Eng. Chem., 44:1576 (1952)

Recih, M. H., Harrison, T. B., Labbe, B. G., Storage Stability of GR-S Polymers; Rubber World, (Sept. 1954)

Riley, M. W., The Fluoro-Elastomers: Latest Weapon Against Heat and Fluids; Materials and Design Eng., (Jul. 1957)

Riley, M. W., A Guide to Synthetic Rubbers; Materials Design Eng., (Sept. 1957)

Rochow, E. G., Rochow, T. G., The Properties and Molecular Weights of Some Silicone Polymors; J. Phys. & Colloid Chem., 55:9 (1951)

Rogers, T. H., Hecker, K. C., Present Status of Latex Rubber Foam; Rubber World, (Dec. 1953)

Rose, K., Rubber as an Engineering Material; Materials & Methods (May 1948)

Rose, K., Two New Syntnetic Rubbers - They Offer: Excellent Chemical Resistance; Long Wear Life and High Toughness and Flexibility; Material and Methods (May 1953)

Rose, K., What's New in Syntnetic Rubber Modifications; Materials & Methods, (Sept. 1953)

Rose, K., Silicones - Properties and Uses; Materials & Methods, (Feb. 1955)

Roush, C. W., Braley, S. A., Effects of Fillers, Vulcanizaing Agents and Additives on Compression Set of Silicone Rubber; Rubber Age, (Oct. 1953)

Ruffell, J. F. E., Hypalon and Neoprene: Some Outstanding Properties; Proc. Inst. Rubber Ind., 4:76 (1957)

Salomon, G., Ameronger, G. J., von, Viersen, G. J. van, Schuur, F., De Dechen, H. C. J., Plastics from Natural Rubber; Ind. Eng. Chem., 43:315 (1951)

Sauer, Wilhelm, Maintenance of Rubber Parts; Ger. 1,037,044 (Aug. 21, 1958)

Showa Electric Wire and Cable Co., Ltd., Heat-Resistant Insulated Electric Wires; Japan 6137 (July 16, 1959)

Smith, T. L., Dependence of the Ultimate Properties of a GR-S Rubber on Strain Rate and Temperature; J. Polymer Sci., 32:99 (1958)

Smith, T. L., Viscoelastic Behavior of Polyisobutylene Under Constant Rates of Elongation; J. Polymer Sci., 20:39 (1956)

Smith, F. M., Properties of Elastomers up to 550° F. Rubber World; 139:533 (1959)

Spencer, W. B., Davis, W. B., Kilbourne, F. L., Compounding of Silicone Rubber; Ind. Eng. Chem., 45:1297 (1953)

Stavely, F. W., Coral Rubber a Cis-1,4 Polyisoprene; Ind. Eng. Chem., 48:778 (1956)

Straka, L. E., Advances in the Uses of Rubber in Engineering, 1949-1950; India Rubber World, (Jan. 1951)

Tryon, M., Natural and Synthetic Rubbers: Review of Industrial Applications; Anal. Chem., 29:714 (1957)

Vacca, G. N., Erickson, R. H., Lundberg, C. V., Aging of Black Neoprene Jackets; Ind. Eng. Chem., 43:443 (1951)

Vacca, G. N., Lundberg, C. V., Aging of Neoprene in a Weather-meter; Wire and Wire Products, 32:418 (1957)

Vanderbilt,News, K-Stay, A New Processing Aid in the Vanderbilt Line; 24:6 (1958)

Vanderbilt News, News Report on the Yale Rubber Manufacturing Co., Sandusky, Mich.; 24:2 (1958)

Vanderbilt News, Nitrile Rubber. Heat Resistant Compounds of Graduated Hardness; 24:12 (1958)

Waggner, C. E., Heat Resistance of Enjay Butyl; Rubber Age, (May 1957)

Vanderbilt News, Thiate, Neoprene Acceleration Studies; 24:8 (1958)

Wakeham, H., Honold, E., Skau, E. L., A Comparison of Some Elastic Properties of Tire Cords; J. Appl. Phys. 16:333 (1945)

Weinstock, K. V., Baker, L. M., Jones, D. H., Recent Developments in the Field of Oil-Enriched Rubbers; Rubber Age, (Dec. 1951)

Wilkinson, F. J., Freeman, G. G., New, N., Noad, R. B., Silicone Rubber Tubing in Blood-Transfusion Work: Clinical Trials; Lancet (Sept. 1956)

Winn, H., Shelton, J. R., Fatigue and Failure of GR-S Tread Stocks; Ind. Eng. Chem., 37:67 (1945)

Anonymous, Urethane Rubber Parts Available in U. S.; Materials & Methods, (Jul . 1956)

Anonymous, Flourine + Silicone Rubber = New Heal and Solvent Resistant Elastomer; Materials & Methods (Nov. 1956)

TESTING BIBLIOGRAPHY

Andrews, R. D., Tobolsky, A. V., Hanson, E. E., The Theory of Permanent Set at Elevated Temperatures in Natural and Synthetic Rubber Vulcanizates; J. Appl. Phys., 17:352 (1946)

Anthony, R. L., Baldwin, F. P., Ivory, J. E., Experimental Examination of the Statistical Theory of Rubber Elasticity. Low Extension Studies; J. Appl. Phys., 26:750 (1955)

ASTM, Conditioning of Elastomeric Materials for Low-Temperature Testing; ASTM Standard d-832-60

ASTM, Evaluating Low-Temperature Characteristics of Rubber and Rubber-Like Materials by a Temperature-Retraction Procedure (T R Test); ASTM Standard d-1329-60

ASTM, Recent Developments in the Evaluation of Natural Rubber, Symposium on, ASTM Special Tech. Pub. 136

ASTM, ASTM Standards on Rubber Products with Related Information Methods of Testing Specifications, Definitions; 19th Edition, March, 1960

Atkinson, E. B., and Eagling, R. G., (BX Plastics Ltd., Lawfor Place, England) Applications of Dynamic Elastic Measurements in Polymer Systems; Soc. Chem.Ind. Monograph, 5:197 (1959)

Barreira, F., Laranjeira, M., Analytical Distinction Between Natural Rubber and Neoprene by Neutron Irradiation; Rev. port. quim., 1:73 (1958)

Baumann, G. F., and Steingiser, S., Calorimetric Differentiation of Polyester and Polyether based Urethan Polymers, J. Appl. Polymer Sci., 1:351 (1959)

Belitskaya, R. M., Determination of the Degree of Unsaturation of Butyl Rubbers; Metody Analiza syr'ya i Materialov Primenyaemykh v Rezin. Prom., Moscow, Sbornik, 54 (1959) Referat. Zhur., Khim., Abstr. No. 79528 (1960)

Bogina, L. L., and Martyukhina, I. P., A Parid Method for the Determination of Total Sulphur in Rubber Compositions and Vulcanizates; Kauchuk i Rezina, 16, 12:27 (1957)

Bogina, L. L., and Martyukhina, I. R., Determination of Total Chlorine and Bromine in Rubber Compositions and Vulcanizates by Combustion Method, Kauchuk i Rezina 18, 2:55 (1959)

Brepson, Roger, and Clement, Marie Louise, Expt. Determination of the Compressibility of Rubber in the Deformed and Non-Deformed State, Compt. Rend., 246:3002 (1958)

Ball, J. A., Randall, R. L., Laboratory Methods of Dynamic Testing of Compounds Containing Reclaimed Rubber; Rubber World, Sep. 1954

Baxter, S., Potts, P. D., Vodden, H. A., Stress Relaxation in Rubber Simultaneous Exygen Absorption; Ind. Eng. Chem., 47:1481 (1955)

Beatty, J. R., A Test for Crystallization Effects in Rubbers; Ind. Rubber World, (Han. 1952)

Bestul, A. B., Composition of Apparent Shearing Forces During Shear Degradation of Polymers; J. Appl. Phys., 25:1069 (1954)

Bestul, A. B., Evidence for Mechanical Shear Degradation of High Polymers; J. Phys. Chem., 61:418 (1957)

Biggs, B. S., Organic Corrosion, Bell Lab. Record, Jan, 1956

Boonstra, B. B. S. T., Some Properties of Vulcanized Rubber Under Strain, Degree of Crystallization as Calculated from Temperature Coefficient of Elastic Tension; Ind. Eng. Chem., 43:362 (1951)

Bowell, S. T., The Errors of Stress-Strain Testing; Rubber Age, Nove. 1952

Boyer, R. F., Relation of Tensile Strength to Brittle Temperature in Plasticized Polymers; J. Appl. Phys., 22:723 (1951)

Braber, P., Salomon, G., Methods of Testing Abrasion and Wear in the Netherlands; Engineering, 173:725 (1952)

Bueche, A. M., Stress Relaxation in Elastomer; J. Chem Phys., 21:614 (1953)

Buist, J. M., Tear Resistance. I. Mechanisms of Tearing of Natural and Synthetic Rubbers; Trans. Inst. Rubber Ind., 20:155 (1945)

Buist, J. M., Tear Initiation and Tear Propagation, Trans. Inst. Rubber Ind., Paper presented at Rubber Technology Conference, London, June 1948

Buist, J. M., Abrasion Resistance and its Measurement; Trans. Inst. Rubber Ind., 26:192 (1950)

Buist, J. M., International Standardization of Rubber Test Methods; Trans. Inst. Rubber Ind., 25:370 (1950)

Buist, J. M., International Standardization of Rubber Test Methods, Akron, 1950; India Rubber J., (March 1951)

Buist, J. M., Abrasion and Wear of Rubber Engineering Fib., 1952

Buist, J. M., Test Methods; A Report of the ISO Meeting in Paris, June, 1953; India Rubber J.,(Sept. 1953)

Buist, J. M., International Standardization of Rubber Test Methods A Report of the ISO Meeting in Dusseldorf; Rubber F., Oct. 1955

Buist, J. M., Polymer Testing and its Contribution to Developments in Industry. Trans. Inst. Rubber Ind., 33:102 (1957)

Buist, J. M., Geldof, H., Comparison of Crescent and Delft Methods of Measuring Tear Strength; India Rubber World, June, 1950

Buist, J. M., Kennedy, R. L., Tear Cutter for Tear Resistance Tests; J. Sci. Instr., 23:242 (1956)

Buist, M. M., Kennedy, R. L., Tear Resistance, More Accurate Results Using I. C. I. Cutter; India Rubber J., (June 1946)

Buist, J. M., Williams, C. E., Belt-Flexing Test of the Du-Pont Type; Trans. Inst. Rubber Ind., 27:209 (1951)

Burleight, E. G., Wakeham. H., Stress Relaxation of Cotton and Rayon Cords at Constant Length; Textile Research J., 17: 245 (1947)

Calhoun, V. B., Minco, R. M., Reed, J. R., Mooney-Viscosity Determinations of Butyl Rubber at Elevated Temperature; Rubber World, 141:688 (1960)

Calhoun, V. B., Reed, J. R., Minco, R. M., Elevated Temperature Method for Determining Mooney Viscosity of Butyl Rubber; Rubber Age, 86:834 (1960)

Carlson, L. E., and Havenhill, R. S., The St. Hoe Ozone Flex Tester for Rubber Compounds, Rubber World, 133:833 (1953)

Case, L. C., Elastomer Behavior. I. Rupture Elongation; Makromol Chem., 37:243 (1960)

Chasset, P., and Thirion P., Longitudinal Tear of Stretched Vulcanizates. I. Methods and Preliminary Results; Rev. Gen. Caoutchouc, 35:165 (1958)

Chilton, E. G., Dynamic Characteristics of Rubber Supports from Vibration Table Data; J. Appl. Phys., 17:492 (1946)

Conant, F. S., Dum, J. L., Cox, C. M., Frictional Properties of Treat-Type Compounds on Ice; Ind. Eng. Chem., 41:120 (1949)

Conant, F. S., Hall, G. L., Lyons, W. J., Equivalent Effects of Time and Temperature in Shear Creep and Recovery of Elastomers; J. Appl. Phys., 21:499 (1950)

Cunningham, J. R., Ivey, D. G., Dynamic Properties of Various Rubbers at High Frequencies; J. Appl. Phys., 27:967 (1956)

Czervinski, W., and Pohoska, J., Determination of Rubber in Rubber Compounds, Przemysl Chem., 34:258 (1955)

Dillon, J. H., Gehman, S. D., Hysterisis and Methods for Its Measurements in Rubber-Like Materials. India Rubber World, (Oct. 1946)

Dillon, J. H., Prettyman, I. B., Hall, G. L., Hysteretic and Elastic Properties of Rubber like Materials under Dynamic Shear Stresses; J. Appl. Phys., 15:309 (1944)

Ecker, Ruprecht, Aging Tests for Rubber; Arch. Tech. Messen, Lfg., 239:31 (1960)

Eller, S. A., Stress Relaxation of Vulcanized Rubber in Compression and Tension; ASTM Bul. no. 207 (1955)

Eller, S. A., Bondek, W. K., A Baboratory Grinding Machine for Preparing Test Specimens from Rubber and Other Flexible Products; ASTM Bul. no. 206 (May 1955)

Enabnit, R. S., Gehman, S. D., Dynamic Properties of Raw and Vulcanized Polymers; Ind. Eng. Chem., 43:346 (1951)

Fletcher, W. P., Gent, A. N., Non-Linearity in the Dynamic Properties of Vulcanized Rubber Compounds; Trans. Inst. Rubber Ind., 29:266 (1953)

Forester, M. J., Unilateral Compression of Rubber; J. Appl. Phys. 26:1101 (1958)

Gee, G., Stern, J., Treloar, L. R. G., Volume Changes in the Stretching of Vulcanized Natural Rubber; Trans. Faraday Soc., 46:1101 (1950)

Gehman, S. D. and Wilkinson, C. S., Flex Testing of Rubber with Bieaxial Stressing, Kautschuk u Gummi, 11:WT215 (1958)

Gehman, S. E., Rubber in Vibration; J. Appl. Phys., 13:402 (1942)

Gehman, S. D., Clifford, R. P., Rubber Evaluation with an Instron Tester; ASTM Spec. Tech. Purb. no. 138 (1953)

Gehman, S. D., Dynamic Properties of Elastomers; Rubber Chem & Tech., 30:1202 (1957)

Gehman, S. E., Jones, P. J., Woodford, D. E., Heat Generation in Flexed Rubber; Ind. Eng. Chem., 35:964 (1943)

Gehman, S. D., Wilkinson, C. S. Jr., Daniels, R. D., Smearing of Vulcanized Rubber; Rubber Chem. and Technol. 28:508 (1955)

Gehman, Woodford, D. E., Stanbaough, R. B., Dynamic Properties of Rubber. Dependence on Pigment Loading; Ind. Eng. Chem., 33:1032 (1941)

Greensmith, H. W., Rupture of Rubber. VII. Effect of Rate of Extension in Tensile Tests; J. Appl. Polymer Sci., 3:174 (1960)

Greensmith, H. W., Rupture of Rubber. VIII. Comparisons of Tear and Tensile Rupture Measurements; J. Appl. Polymer Sci. 3:183 (1960)

Griffin, W. R., Evaluation of Experimental Polymerizates of Wright Air Development Center; Rubber World, 136:687 (1957)

Gridunov, I. T., etal, Appartus for Fatigue of Rubber, Kauchuk i Rezina 18, 6:50 (1959)

Gurney, W. A., and Cheetham, I. C., Factors Influencing Cut Growth Testing, Trans. Inst. Rubber Ind., 35:45 (1959)

Goldfein, S., Formula to Describe the Tim-Temperature Relationship for Creep and Rupture Stresses in Plastic Material; Army Eng. Research and Dev Lab., Ft. Belvoir, Va., Report No. 2409-17 Feb. 1959

Goodman, P., Bestul, A. B., Temperature Dependence of Mechanical Shear Degradation; J. Polymer Sci. 18:235 (1955)

Graves, F. L., The Evaluation of Tear Resistance in Elastomers; India Rubber World, 111 Dec. 1944

Greensmith, H. W., Rupture of Rubber, IV. Tear Properties of Vulcanizates Containing Carbon Black; J. Polymer Sci., 21:175 (1956)

Greensmith, H. W., Thomas, A. C., Rupture of Rubber. II. The Strain Concentration at an Incision. III. Determination of Tear Properties; J. Polymer Sci., 18L177 (1955)

Gregory, J. B., Pockel, I., Stiff, J. F., Effect of Storage and Temperature on Flexibility of Natural and Synthetic Rubbers; India Rubber world, (Feb. 1943)

Gui, K. E., Wilkinson, C. S., Gehman, S. D., Vibration Characteristics of Tread Stocks; Ind. Eng. Chem., 44:720 (1952)

Hatfield, M. R., Rathmann, G. B., Constant Stress Elongation of Soft Polymers; Plasticizer Studies; J. Appl. Phys., 25:1032 (1954)

Havenhill, R. S., O'Brien, H. C., Rankin, J. J., Electrostatic and Tensile Properties of Rubber and GR-S at Elevated Temperatures; J. Appl. Phys., 17:338 (1946)

Honold, E., Wakeham, H., Hysteresis, Elastic Modulus, and Growth of Tire Cords Under Comparable Loads; Ind. Eng. Chem., 40L131 (1948)

Haines, R. and Gould, E. G., Apparatus for Hot Tear Testing, Proc. Inst. Rubber Ind., & 6:85 (1959)

Jones, H. C., Synder, E. G., Effect of Temperature on Resilience of Natural and Synthetic Rubber; India Rubber World, 108: May 1943

Hewitt, F., and Anthony, R., Measurement of the Isothermal Volume Dilation Accompanying the Unilateral Extension of Rubber; J. Appl. Phsy., 29:1411 (1958)

Fielding, J. H., Juve, A. E., Grave, F. L., Report on Correlation of Laboratory and Service Abrasion Test of Rubber Tire Treads; ASTM Bul. (1947)

Kasatkina, N., Determinatio of the Percentage of 1,4; 3,4; and 1,2 Isoprene Units in Synthetic Isoprene Rubbers by the Curves of the Rate of Oxidation with Benzoyl Peroxide, Zhur. Priklod. Khim., 32:170 (1959)

Kase, Shigeo, Method for Adjusting Tensile Date of Vulcanizates. X.; Nippon Gomu Kyokaishi, 33:266 (1960)

Kirchhof, F., The Weber Color Test for Analytically Distinguishing Natural Rubber from Butyl Rubber, Polyisobutylene, and Cyclorubber; Kautschuk u Gummi, 13 WT402 (1960)

Korol, J. Viscous Flow of Rubber I. Method of Constant Deformation, Zhur. Tekh. Fiz. 29:471 (1959)

Kragelskii, I., The Wearing Quality of Tread Stocks, Kauchuk i Rezina 18, 11:20 (1959)

Legoni, H. and Merten, D., A Method for Recording Damage to Rubber Surfaces, Naturwissenschaften 44:177 (1957)

Lavery, T. F., Grover, F. S., Smith, S., Kitchen, L. J., Equipment for High-Temperature Testing; Rubber Age, (Feb. 1957)

Lichtman, J. Z., Chatten, C. K., Physical Properties of Natural and Synthetic Rubber Materials at Low Temperatures; Anal. Chem., 24:312 (1952)

Mano, Eloisa, B., Rapid Test for Identification of Natural Rubber in Vulcanizates; Anais Assoc. Brasil Quim., 18:223 (1959) Rubber Chem. Technol., 33:591 (1960)

Miksch, R., Prolss, L., Identification of Blowing Agents and Plasticizers in Rubber Mixtures; Gummi u. Asbest, 13:250 (1960)

Maron, B. J., Control of Errors in Physical Test Calculations in a Rubber Laboratory; India Rubber J., (Jan. 1954)

Maron, S., Ulevitch, I. N., Mechanical Stability Test for Rubber Latices; Anal. Chem., 25:1087 (July 1953)

Marshall, D. G., Walker, D. L., Softening of Bulcanized Black-Loaded Rubber During Extension; Trans. Inst. Rubber Ind., 31:115 (1955)

Martin, B. J., Control of Errors in Physical Test Calculations in a Rubber Laboratory; India Rubber J., (Jan. 1954)

Millard, J., Relat[illegible] of Physical Testing to the Uses of Pressure Sensitive Ad[illegible]siv[illegible] Products, Proc. Inst. Rubber Ind., 6:93 (1959)

Mozisek, M., Measureme[illegible] of Sulfur Diffusion Through Tire Tread Rubber; Plas[illegible] [illegible] K[illegible]utschuk 6, 2:65 (1959)

Mooney, M., A Diffusion Theory of the Visco-Elasticity of Rubbery Polymers in Finite Elastic Strain; J. Polymer Sci., 34:599 (1959)

Mooney, M., Black, S. A., Elongation Hysteresis of Hevea and Synthetic Elastomers; Can. J. Research, 28:83 (1950)

Morris, R. E., Barrett, A. E., Permanence of Plasticizers in GR-S Vulcanizates Exposed to Weather; Rubber Age, (Aprill 1954)

Morris, R. E., Bonnar, R. U., Precision of Tests for Tear Resistance; Anal. Chem., 19:436 (1947)

Morris, R. E., Holloway, J. M., Evaluation of I.S.O. Micro Hardness Tester; ASTM Bul. no. 222 (May 1957)

Morris, R. E., James, R. R., Guyton, C. W., A New Method for Determining the Dynamic Mechanical Properties of Rubber; Rubber Age, (Feb. 1956)

Nakahara, K., et al, Abrasion Test of Elastic Rubber, Nippon Gomu Kyokaishi, 31:961 (1958)

Newnham, J. L. M., Simeox, D. J., Zinc Oxide Stability Testing of Natural and Synthetic Latexes; Trans. Inst. Rubber Ind., 36:234 (1960)

Oakes, W. G., Robinson, D. W., Dynamic Electrical and Mecnanical Properties of Polythene Over a Wide Temperature Range; J. Polymer Sci., 14:505 (1954)

Oehme, F., Testing Materials with Dielectric Methods, Kunstoff-Rundschau, 5:524 (1958)

O'Brien, J. B., Synthetic Rubber Testing Simplified Through Air Conditioning; Surface Combustion Corp., No official Pub.

Ore, Svein, A Modification of the Method of Intermitten Stress Relaxation Measurements on Rubber Vulcanizates; J. Appl. Polymer Sci., 2:318 (1959)

Othmer, D. F., Harrison, J. G., Alignment Chart for Tensile Strength of Rubber and Plastic Compounds; India Rubber World, (Oct. 1945)

Painter, G. W., Rubber to Metal Adhesion; Rubber Age, 86:262 (1959)

Petrosyan, G., Repeated Loading-Unloading of Samples of Soft Vulcanized Natural Rubber; Sbornik Nauch. Trudov. Ereyan. Politekh. Inst., 14:47 (1957)

Philippoff, W., Mechanical Investigations of Elastomers in a Wide Range of Frequencies; J. Appl. Phys., 24:685 (1953)

Popov, A., Gydeva, V., The Determination of Accelerators and Antioxidants in Rubber Stocks. I. The Use of Precipitation Chromatography for the Detection of Some Accelerators; Compt. Rend. acod. bulgare sci., 12:419 (1959)

Redfern, C., et al, De Mattia FlexResistance Tests on Rubber-like materials, Brit. Plastics, 31:433 (1958)

Reznikovskii, M., Evolution of Heat During Deformations of Rubber and New Methods of Dynamic Tests, Starenie Utomlenie Kauchkov i Rezin i Povyshenie ikh stoikosti Sobornik, 63:75 (1955)

Roamsdonk, G. W. van, The Significance of Accelerated Aging Tests Rubber Stichting, Delft Commun. No. 295

Roelig, H., Schmahl, J., Improvement of a Test Machine for Determining the Damping Properties of Polymers; Kautschuk u. Gummi, 13:WT221 (1960)

Robinson, H. W. H., Vodden, H. A., Stress Relaxation in Rubber, Evaluation of Antioxidants; Ind. Eng. Chem., 47:1477 (1955)

Roth, E. L., Schade, J. W., Developments & Improvements in Methods of Stress-Strain Testing of Rubber; ASTM Symposium on Rebber Testing, (1947)

Roth, F. L., Stiehler, R. D., Tension Testing of Rubber Rings; ASTM Bul. No. 233 (Oct. 1953)

Rozaci, O., Polarographic Determination of Free Sulfur in Rubber and Rubber Compounding Chemicals, Chem prumysl, 33:335 (1958)

Schronkler, F. W., Electrical Measurements for Interpreting Activation, Oxygen Effect, and Zinc Dithiocarbamate Function During the Vulcanization of Synthetic Rubber; Kautschuk u. Gummi, 14:WT61 (1961)

Schmuckal, R. P., Rubber has Dynamic Properties Too; Paper presented at SAE National Passenger Car, Body and Materials melting, Detroit, Michigan, March, 1955

Schoal, A. W., A Method of Measuring "Heat Embrittlement" of GR-S and Hevea Rubber Compounds; India Rubber World, (Feb. 1947)

Scott, J. R., Improvements in Accuracy of Hardness Testing; Trans. Inst. Rubber Ind., 27:249 (1951)

Scott, J., and Soden, A., Microhardness Testing, Its Possibilities and Limitations, Trans. Inst. Rubber Ind., 36:1 (1960)

Scott, Jr., Rubber Testing Methods; 1955 International meeting; Proc. Inst. Rubber Ind., 2:208 (1955)

Scott, J. R., Rubber Hardness Testing; Rubber Age, (July 1955)

Shaw, R. F., Adams, S. R., Nondestructive Aging Tests for Rubber; Anal Chem., 23:1649 (1951)

Shearer, R., An Automatic Spark Recorder for Stress-Strain Testing; India Rubber World, (July, 1947)

Sheltonk J. R., McDonel, E. T., An Apparatus for Quantitative Gas-Absorption Measurements; J. Appl. Polymer Sci., 1:336 (1959)

Simpson, W. J., Status of Acclerated Testing of Automotive Rubber Parts; Paper presented at SAE meeting, Atlantid City, June, 1957

Smith, F. B., Tulgy, W. F., Accelerated Testing of Oxone Cracking Inhibitors; Rubber World, 140:243 (1959)

Smith, Ward A., Willis, James ., Compounding and Testing Diene Rubber; Rubber Age, 87:315 (1960)

Smith, J. F., Rubber Mounting, J. Appl. Mechanics, Mar. 1938

Smith, J. F. D., Rubber Springs-Sheas Loading; J. Appl. Mechanics, Dec. 1939

Smith, J. F. D., Rubber Springs Under Compression Loading; Iowa Engineering Experiment Station Report No. 2, 1950-51

Smith, J. F. D., Rubber Springs-Sheas Loading-II; Trans, Am. Soc. Mech. Eng., April 1948

Smith, J. F. D., Reseaach on Rubber for Mechanical Engineers; Mech. Eng. (Feb. 1943)

Smith, J. F. D., The Design of Rubber Mounting; Iowa Engineering Experiment Station Report No. 2, 1950-51

Stambough, R. B., Vibration Properties of Rubber-like Materials Dependence on Temperature; Ind. Eng. Chem., 34:1358 (1942)

Soden, A., Resting, Equipment and Specifications Other Then for Latex, Ann. Rept. Prog. Rubber Technol. pp . 39-45

Spath, W., Hardness Measurements of Hard Rubber, Gummi u. Asbest, 11:494 (1958)

Stepanove, V. Pphtocolorimetric Method of Determination of Diphenyl Guanadine in Raw Rubber Mixtures and Vulcanizates, Turdy Nauch-Issledovatel Inst. Rezin Prom, 1955, No. 2,:190 Abstr. No. 48627

Stepanova, V., Photocolorimetric Method of Determination of Thiuram In Rubber, Raw Rubber Mixtures and Vulcanizates, Turdy Nauch-Issledovatel Inst. Rezin Prom, 1955, No. 2:194 Abstr. No. 48626

Stambaugh, R. B., Electrical Analog Method for Studying Elastomer Behavior; Ind. Eng. Chem., 44:590 (1952)

Stambough, R. B., Rohner, M., Gehman, S. D., Speed of Retraction of Rubber; J. Appl. Phys., 15:740 (1944)

Stedman, D. F., A Concentent Ring Mould for Rubber Testing; Can J. Research, 6:513 (1932)

Stedman, D. F., Stress-Strain Curves for Fatigues Rubber; Can. J. Research, 28:31 (1950)

Stiehler, R. D., Improvements in Rubber Testing in the Government Synthetic Rubber Program; Anal Chem., 20:292 (1948)

Straka, L. E., Rubber Developments: June 1957-June 1959; Paper presented at annual meeting ASME, Atlantic City, Dec. 1959

Taylor, R. H., Fixtures Aid in Shappening Dies used to Cut Rubber Tensile Test Specimens; India Rubber World, Jan. 1951

Thomas, A. G., Rupture of Rubber. VI. Further Experiments on the Tear Criterion; J. Appl. Polymer Sci., 3:168 (1960)

Thomas, A. G., Rupture of Rubber. V. Cut Growth in Natural Rubber Vulcanizates; J. Polymer Sci., 31:467 (1958)

Tichava, M., Contribution to the Method of Estimating the Tear Strength of Rubber; Chem prumysl, 9:438 (1959)

Tichava, Microslav, Abrasion-Testing Machine Working with Constant Friction for the Testing of Rubber; Chem prumysl, 10:489 (1960)

Tobolsky, A. V., Prettyman, I. B., Billon, J. H., Stress Relaxation of Natural and Synthetic Rubber Stocks; J. Appl. Phys. 15:380 (1944)

Taylor, R. H. ~~Rubber~~ Use of the Shore Durometer for Measuring the Hardness of Synthetic and Natural Rubbers; ASTM Bul No. 123, Aug. 1943

Vovra, Jozef, Application of Zimm's Method for the Determination of the Molecular Weight of Natural Rubber; Chem zvesti, 14:3 (1960)

Vervloet, Ch., Laboratory Abrasion Tests of Black Filled Vulcanizates, Kautschuk u. Gummi, 11:WT336, WT342 (1958)

Vodden, H., and Wilson, M., Stress-Relaxation Method of Measuring Ozone Cracking in Rubber, Trans Inst. Rubber Ind., 35:82 (1959)

Wakeham, H., Honold, E., Application of the Torsional Hysteresis Test to Tires; India Rubber World, 103:377 (1945)

Wakeham, H., Honold, E., Hysteresis and Related Elastic Properties of Tire Cords; J. Appl. Phys., 17:698 (1946)

Williams, G. E., Testing, Equipment, and Specifications Other than for Latex; Ann. Rept. Progr. Rubber Technol, 23:47 (1959)

Wilkinson, C. S. Fr., Gehman, S. D., Autopneumatic Apparatus for Measuring Stress Relaxation; Anal. Chem., 22:1439 (1950)

Wilkinson, C. S. Fr., Gehman, S. D., Hysteresis Determination With the Goodyear-Roelig Machine; Anal. Chem., 22:283 (1950)

Youden, W. J., Statistical Design, Data on Physical Properties of Rubber Exemplify Problems of Data Evaluation and Estimation of Error; Ind. Eng. Chem.,(June 1956)

Zapp, R. L, Abrasion of Buty Rubber; Rubber World, (Oct. 1955)

Zapp, R. L., Umland, C. W., Sperberg, L. R., Butyl Tire Tread Abrasion; Rubber World, 141:669 (1960)

OXIDATION BIBLIOGRAPHY

Angert, L. G., Kuzminskii, A. S., Efficiency of Rubber Oxidation Inhibitors at Various Temperatures; Mezhdunarod. Simpozium po Makromol. Khim., Doklady, Moscow, Sektsiya 3:423 (1960)

Bauman, R. G., Maron, S. H., Oxidation of Polybutadiene. I. Rate of Oxidation: J. Polymer Sci., 22:1 (1956)

Bauman, R. G., Maron, S. H., The Oxidation of Polybutadiene. II. Property Changes During Oxidation; J. Polymer Sci., 22:203 (1956)

Baxter, S., Morgan, W., Roebuck, D. S. P., Rubber Oxidation and Antioxidant Actions: Ind. Eng., Chem., 43:446 (1951)

Bevilacqua, E. M., The Reaction of Molecular Oxygen with Rubber Age, (Nov., 1956)

Bevilacqua, E. M., Chain Scission in the Oxidation of Hevea. IV. Low Molecular Weight Products from Dry Rubber; J. Am. Chem. Soc., 79:2915 (1957)

Bevilacqua, E. M., End Groups of Oxidized Rubber; Science, 126:396 (1957)

Bevilacqua, E. M., Degradation of Polyisoprene Networks by Oxygen; J. Am. Chem. Soc., 80:5364 (1958)

Bevilacqua, E. M., Oxidation of Hevea Vulcanizates Containing Carbon Black; J. Am. Chem. Soc., 81:5071 (1959); Rubber Chem. Technol., 33:60 (1960)

Blumm, G. W., Shelton, J. R., Winn, H., Rubber Oxidation and Aging Studies. Safe Limits of Sample Thickness; Ind. Eng. Chem., 43:464 (1951)

Briggs, B. S., The Protection of Rubber against Atmospheric Ozone-Cracking; Rubber Chem. and Technol., 31:1015 (1958)

Carpenter, A. S., Absorption of Oxygen by Rubbers; Rubber Chem. and Technol. 20:728 (1947)

Cotton, F. H., Lee, K. O., Mastication of Natural Rubber. Oxygen Uptake During Mastication of Rubber; Research. 4:44 (1951)

Davirts, E. Ya., Novikov, A. S., Effect of Oxidation-Reduction Systems on the Thermo-Oxidative Plasticization of Butadiene-Nitrile Rubbers; Kauchuk i Rezina, 18:17 (1959)

Degteva, T. G., Belitskaya, R. M., Kuzminskii, A. S., Physical Chemical Foundation of the process of Oxidative Degradation of Swollen Vulcanized Rubber. I. The Concurrent Oxidation of Rubber and Solvent in Swollen Vulcanized Rubber; Trudy Nauch. - Issledovatel, Inst. Rezin. Prom., :73 (1956)

Devirts, E., and Novikov, A. S., Effect of Oxidation Reduction Systems on the Oxidative Plasticization of Butadiene-nitrile Rubbers, Kauchuk i Rezina, 18, No. 11, 17, (1959)

Dogadkin, B. A., Sandomirskii, D. M., et al, Manufacture and Properties of Lacquer for Rubber Boots and shoes by Oxidation of Dissolved Buna Rubber; Plaste u. Kautschuk, 7:182 (1960)

Dufraisse, C., L'Oxydabilite' Consideree Comme Test D'Etat du Caoutchouc; Signification; Conception Pratique, Causes D'Erreurs Approximation, Rev. Gen. Caoutchouc, 16: 18:185 (1941)

Dufraisse, C., Manometre Pour la Mesure de L'Oxydabilite; Rev. Gen. Caoutchouc., 18:185 (June, 1939)

Dufraisse, C., Etienne, A. Influence de la Vulcanization sur L'Oxydabilite' en Relation Aver le Vieillissement. Etude Preliminaire; Commun. Intern. Rubber Congr., Paris, June, (1937)

Dufraisse, C., Le Bras, J., Sur le Controle Ultra-Rapide du Caoutchouc; Test D'Oxydabilite en un Quart D'heure; Rev. Gen. Caoutchouc., 17:9 (1940)

Dufraisse, C., Le Bras, J., Influence de la Vulcanization sur L'Oxydabilite du Caoutchouc. I. Cas D'Agents Vulcanisants Autres Que le Soufre; Rev. Gen Caoutchouc, 18:79 (1941)

Dunn, J. R., et al, Stress Relaxation During the Thermal Oxidation of Vulcanized Natural Rubber, Trans-Faraday Soc., 55:667 (1959)

Dunn, J. R., (Brit. Rubber Producers Research Assoc. Welwyn Garden City, Engl.), Stress Relaxation During the Photo Oxidation of Peroxide Cross-Linked Rubber, Trans. Fraday Soc., 54, 730, (1958)

Dunn, J. R., Oxidative Stress Relaxation of Radiation Vulcanizates with and without Antioxidants; Kautschuk u. Gummi, 14:WT 114 (1961)

Dunn, J. R., Scanlan, J., Metal Dialkyl Dithiophosphates as Retarders of the Oxidative Degradation of Natural Rubber; J. Polymer Sce., 35:267 (1959)

Ermolenko, N. F., Kazak, T. S. Kinetics of the Oxidation of Natural Rubber in the Presence of the Inhibitor 2, 4 - diamino diphenylamine; Doklady Akad. Nauk Beloruss. S. S. R., 3:442 (1959)

Fackler, Marion B., Rurg, John S., Migration of Materials during Accelerated Aging by Oxygen Pressure Method; Anal. Chem., 23:1646 (1951)

Goodyear Tire and Rubber Co., Phenolic Antioxidents for Rubber; Brit. 818,035 (Aug. 12, 1959)

Hillmer, K., and Scheele, W. (Tech. Hochschule, Hannover, Ger.) The Degradation of Elastomers II. The Oxidative Degradation of Natural Rubber at Different Elongations and Temperatures, Kautschuk u Gummi II 210 (1958)

Kasatkina, N., Determination of the Percentage of 1, 4: 3, 4; and 1, 2 Isoprene Units in Synthetic Isoprene Rubbers by the Curves of the Rate of Oxidation with Benzoyl Peroxide, Zhur, Priklod. Khim. 32 170 (1959)

Kawamatsu, Shunji, Harada, Minoru, Oxidation of High Polymers. III. Initial Degradation of High Polymers; Kobunshi Kagaku, 15:517 (1958)

Khodkevich, L., Thermooxidizing Deterioration of Butadiene Nitrile Rubber (NBR) in Presence of Accelerators of Mastication: Leka Prom., 8:12 (1959)

Kiriyama, S., and Kuraya, T. (Osaka Munic. Univ.) Studies on the Mechanism of Mastication of Rubber XIII. Absorption Velocity of Oxygen by Various Kinds of Natural Rubber, Nippon Gomu Kyokaishi 30 847 (1957)

Kirshenbaum, A. D., Streng, A. G., Nellen, A. H., A Study of the Oxidation of Rubber by Means of the Isotopid Method; Rubber Age, February,(1953)

Kuzminskii, A., and Lyubchanskaya, L. (Leningrad: Gosudarst Nauch.) Effect of Mechanical Stresses on Oxidative Processes, Starenic i Utomlenii Kauchukov i Rezin i Povyshenic ikh Stoikosti Sobovnik 1955 89:99 Referat Zhur. Khim. 1957 Abstr. No. 6031

Lawrence, J. W., Shelton, J. R., Oxidation of Compounds Structurally Related to GR-S; Ind. Eng. Chem., 42:136 (1950)

Le Bras, J., Influence de la Vulcanisation sur L'Oxydabilite du Caoutchouc. II. Agents Vulcanisants Autres Que le Soufre; Rev. Gen. Caoutchouc. 21:3 (1944)

Le Bras, J., Remarques sur L'Autoxydation du Caoutchouc et les Mecanismes de protection Contre L'Oxygene; Rev. Gen. Caoutchouc, 21:89 (1944)

Marvel, C. S., et al., Oxidative Hydrolysis of the Ozonides of Poly-butadienes, II. Isolation of 1,2,3 - Propanetricarboxylic Acid; J. Org. Chem., 16:838 (1951)

Marvel, C. S., Bloestein, C., Shilling, W. M., Sheth, P. G., Oxidative Hydrolysis of the ozonides of Poly-Butadienes III. Unexpected Cleavage Products; J. Org. Chem., 16:854 (1951)

McDonel, E., and Shelton, J. (Case Inst. of Technol., Cleveland, Ohio) Effect of Curing System on Rubber Oxidation and Physical Degradation, J. Chem. End. Data 4, 360 (1959)

Mitchell, G. R., Shelton, J. R., Products of Oxidation of an Olefin Structurally Related to GR-R; Ind. Eng. Chem., 45:386 (1953)

Neal, A. M., The Limitations of Rubber. I. Influence of Oxygen; E. I. du Pont Report no. 38-1 (1938)

Neal, A. M., Bimmerman, H. G., Vincent, J. R., Effect of Temperature and Pressure on Oxygen Pressure Aging; Ind. Eng. Chem., 34:1352 (1942)

Novikova, E., and Ermolenko, N.; Relation Between Sorption and the Protective Action of Inhibitors in Oxidized Rubbers: Sbornik Nauch. Rabot, Akad, Nauk Belaruss, S.S.S.R Inst. Khim. 1958 No. 6 133-44

Novikova, E., and Ermolenko, N., Uchenye Zapiski Belorus, Gosudarst. Univ. im V.I. Lenina, Ser. Khim. Oxidation of Rubber Films in the Presence of Inhibitors and Initiators. 1956 No. 29. 197

Ore, S., The Oxidative Stress Relaxation of Natural Rubber Vulcanized With Di-tert-butyl peroxide, Oslo Univ. Press 1958 1-84

Pidersen, H. L., The Oxidation of Rubber Vulcanisates; Acta. Chem., Scand., 4:487 (1950)

Pollack, Louis R., Determination of Oxygen Absorption Rate; Taken from a round-robin test evaluation program performed by 3 navy and 3 manufactures (laboratories. Project 1190-2 Mare Island Naval ship-yard.)

Pollack Louis R., Oxygen Absorption Versus Conventional Aging of Commercial Vulcanizates. Ind. Rubber World, (Apr., 1954)

Pollack, Louis R., McElwain, Robert E., Wagner, Paul T., Oxygen absorption of Vulcanizates; A Means of Evaluating Aging Resistance; Ind. Eng. Chem., 41:2280 (1949)

Rao, N. V. C., Winn, H., Shelton, J. R., Oxidation of Hevea and GR-S Polymers and Their Vulcanizates. Effect of Various Coagulants; Ind. Eng. Chem., 44:76 (1952)

Shelton, J. R., Oxygen-Absorption Methods. Their Utility and Limitations in the Study of Aging; ASTM Special Tech. Pub. No. 89 (1949)

Shelton, J. R., Oxygen-Aborption Studies on Olefins with Structures Related to GR-S; Nat. Br. Standards. U. S. Circ. 525, (1953)

Shelton, J. R., Aging and Oxidation of Elastomers; Rubber Chem., and Technol. 30:1251 (1957)

Shelton, J. R., Cox, W. L., Volumetric Oxygen-Absorption Test for Rubber Aging; Ind. Eng. Chem., 43:456 (1951)

Shelton, J. R., Cox, W. L., Effect of Oxygen Concentration on Aging of Rubber Vulcanizates. Effect of Partial Pressure of Oxygen on Rate of Oxygen Absorption. Ind. Eng. Chem., 45:382 (1953)

Shelton, J. R., Cox, W. L., Oxidation and Antioxidant Action in Rubber Vulcanizates; Ind. Eng. Chem., 46:816 (1954)

Shelton, J. R., Cox, W. L., Wickham, W. T., Effect of Inhibitor Variations in Rubber Vulcanizates; Ind. Eng. Chem., 47:2559 (1955)

Shelton, J. R., Winn, H., Aging of GR-S Vulcanizates in Air, Oxygen and Nitrogen; Ind. Eng. Chem., 36:728 (1944)

Shelton, J. R., Winn, H., Oxidation of GR-S Vulcanizates; Ind. Eng. Chem., 38:71 (1946)

Stafford, R. L., Oxygen-Absorption Effects in Cured and Uncured Natural Rubber; Proceedings of the Third Rub. Tech. Con., (1954)

Tinyakova, E., et al, Oxidation-Reduction Systems for Initiation of Radical Processes. VI. Systems with Participation of Oxygen for Initiation of the Process of Molecular Weight Distributions of Polymers, Bull, Acad. Sci. U.S.S.R., Div. Chem. Sci. 1957 1135 (Engl. translation)

Tobolsky, A. V., Mercurio, A., Oxidative Degradation of Polydiene Vulcanizates; J. Appl. Polymer Sci., 2:186 (1959)

Tryon, Max, Wall, Leo A., Oxidative Degradation of a Series of Deuterated Styrene Polymers; J. Phys. Chem., 62:697 (1958)

Vith, A. G., Oxidation Rate Measurements of Hevea Rubber Vulcanizates; Ind. Eng. Chem., 29:1775 (1957)

Wall, Leo A., Harvery, Mary R., Tryon, Max, Oxidative Degradation of Styrene and a-Deuterostyrene Polymers; J. Phys. Chem., 60:1306 (1956)

Warner, W. C., Shelton, J. R., Oxidation of Olefins Representing Some Structural Units of GR-S; Ind. Eng. Chem., 43:1160 (1951)

Winn, H., Shelton, J. R., Effect of Certain Antioxidants in GR-S. Oxygen Absorption Studies Ind. Eng. Chem., 40:2081 (1948)

OZONE BIBLIOGRAPHY

Allison, A. R., Delman, A. D., Simms, B. B., Evaluation of Chemical Protectants as Inhibitors of Ozone-Induced Degradation of GR-S; Anal. Chem., 26:1589 (Oct. 1954)

Allison, A. R., Stanley, I. J., Ozone Deteriation of Elastomeric Materials; Anal. Chem., 24:630 (Apr. 1952)

Ambelang, Joseph C., Antiozonants for Butadiene-Styrene Rubbery Copolymers; U. S. 2, 905, 654 (Sept. 22, 1959)

ASTM, Symposium on Effect of Ozone on Rubber, St. Louis, Mo.; Feb. 1958, Special Technical Publication No. 229

Beatty, J. R. Juve, A. E., A Simple Objective Method for Estimating Low Concentrations of Ozone in Air; Rubber World, (Nov. 1954)

Bibliography on Ozone Deterioration of Rubber; Prevention of Deterioration Center, Division of Chemistry and Chemical Technology, National Academy of Sciences, National Research Council, (Nov., 1957) Revised Sept., 1960

Boucher, M., Jesquet, G., Quelques Presicions sur un Nouvel Agent de Protection: Le KPN:-1; Rev. Gen. Caoutchouc; 35:904 (1958)

Buckley, D. J., Robison, S. B., Ozone Attack on Rubber Vulcanizates J. Polymer Sci., 19:145 (1956)

Buist, J. M., Flexcracking and Crack Growth Tests: Some Important Factors; Trans. Inst. Rubber Ind., 29:72 (1953)

Buist, J. M., Williams, G. E., A Review of the Mechanism of Flex-cracking and Flex-Cracking Tests; India Rubber World, (Jun. Jul. Aug. 1951)

Buist, J. M., Williams, G. E., Crack Growth Testing: Variation Between Laboratories; ASTM Bulletin No. 205 (Apr. 1955)

Crabtree, J., Biggs, B. S., Cracking of Stressed Rubber by Free Radicals; J. of Polymer Sci., 11:280 (1953) RI 7016

Cox, Wm. L., (Universal Oil Products Co., Des Plaines, Ill.).Chemical Antiozonants and Factors Affecting Their Utility, Am. Soc. Testing Materials Spec. Tech. Publ., No. 229. 57, (1958)

Delman, A. D., Simms, B. B., Ruff, A. E., Mechaism of Ozone Degradation of SBR; J. Polymer Sci., 45:415 (1960

Dunkel, W. L., Phelan, R. R., Accelerated Ozone Agine; Enjay Laboratories, (Sept. 1957)

Ecches, S., L'Azione Dell' Ozono nel Fenomeno delle Screpolature della Gomma Sottoposta a Sollecitazione Meccaniche Ripetute; Gomma, 4:1 (1940)

Edwards, T. C., Sorey, E. B., Ozone Resistance of Butyl Vulcanizates; Trans. Inst. Rubber Ind., 31:45 (1955)

Erickson, E. R., et al, (Augustana Research Foundation, Rock Island, Ill.), A Study of the Reaction of Ozpne with Polybutadiene Rubbers, Am. Soc. Testing Material, Spec. Tech. Publ., No. 229, 11, (1958)

Greene, Albert J., Protection of Rubber Against Ozone, U. S. 2, 926, 155 (Feb. 23, 1960)

Grossman, R. F., Bluestein, A. C., Ozone Resistance of Butyl Rubber; Rubber Age, 84:440 (1958)

Karmitz, P., Contribution a L'Etude de la Protection der Caoutchouc Contre les Agents Atmospheriques. I. Examen de Quelques Composis Organiques du Nickel, Rev. Gen. Caoutchouc, 35:913 (1958)

Koller, L. R., The Production and Decomposition of Ozone by Low Pressure Mercury Vapor Lamps; J. of Appl. Phys., 16:816 (1945)

Leigh-Dugmore, C. H., The Ozone Cracking of Rubber; Rub. Age and Syn., 33:9.10 (Nov. Dec. 1952)

Lundberg, C. V., Vacca, G. N., Biggs, B. S., Resistance of Rubber Compounds to Outdoor and Accelerated Ozone Attack; Presented Before the Division of Rubber Chemistry, ACS, Atlantic City, N. J., Sept, (1956)

Manufactures de produits chimiques du Nord, Protection of Elastomers Against Atmospheric Agents; Fr. 1, 151, 090 (Jan. 23, 1958)

Milnes, D. J., Artificial Weathering of Rubber (The ozone factor in weathering and a technique for generation and control of an ozonized atmosphere.); Rubber Age. (Mar. 1955)

Neu, F., Ozone Resistance and Weatherability of Butyl Compounds; Rubber Age, 5:81 (May 1957)

Northam, A. J., The Limitations of Rubber, II. Influence of Light and Ozone; Report No. 38-2, Rubber Chemists Division, E. I. du Pont de Nimours and Co., (Feb. 1938)

Ossefort, Z. T., Ozone Bibliography; RIA Lab. No. 55-88 (Jan. 1955)

Ossefort, Z. T., Ozone Resistance of Elastomeric Vulcanizates; Symposium on Effect of Ozone on Rubber, ASTM Spec. Tech. Publ. No. 229 (1958)

Ossefort, Z. T., Ozone Resistance of Elastomeric Vulcanizates ASTM Symposium, (Feb. 1958)

Ossefort, Z. T., Touhey, W. J., Ozone Crazing of Biaxially Stressed GR-S Vulcanizates; Rubber World, 132:62 (1955)

Perrott, Walter O., Ozone Resistance of Natural-Rubber Tires; U. S. Govt. Research Repts., 31:159 (1959)

Popp, G. E., Harbison, L., Ozone and Sunlight Effect on Aging of Carbon Black Vulcanizates; Ind. Eng. Chem., 44:837 (Apr. 1952)

Rugg, J. S., Ozone Crack Depth Analysis for Rubber, Anal. Chem., 24:818 (1952)

Sharpe, P. D., Petroleum Waxes for Protecting Rubber Compounds From Cracking; Rubber Age, (Sept. 1955)

Smith, D. M., Gough, V. E., Ozone Cracking; A Cinematographic Study; Rubber Chem. and Technol, (Jan. Mar. 1954)

Smith, G. E. P., Antiflex-Cracking Agents in Rubber; U. S. Patent Office No. 2,481,906 (Jan. 1952)

Thompson, D. C., Baker, R. H., Brownlow, R. W., Ozone Resistance of Neoprene Vulcanizates, Effect of Compounding Ingredients; Ind. Eng. Chem., 44:850 (1952)

Throdahl, M. C., Device for Evaluating Surface Cracking of GR-S Ind. Eng. Chem., 39:514 (1947)

Vacca, G. (Bell Telephone Labs.) Comparison of Accelerated and Natural Tests for Ozone Resistance of Elastomers, Am. Soc. Testing Materials Spec. Tech. Publ. No. 229 88 (1958)

Veith, A. (B. F. Goodrich Reasearch Center, Brecksville, Ohio) Report on Inter-Laboratory Ozone Test Program of ASTM Committee D-11, Subcommittee XV on Life Tests for Rubber Products 1957, Am. Soc. Testing Materials, Spec., Tech. Publ. No. 229 113 (1958)

Veith, A., Quantitativa Measurement of Rate of Ozone Cracking, Am. Soc. Testing Materials, Spec. Tech. Publ. No. 229 97 (1958)

Vodden, H., and Wilson, M. (Monsanto Chemicals Ltd., Ruabon, Engl.) Stress-Relaxation Method of Measuring Ozone Cracking in Rubber, trans Inst. Rubber Ind. 35 82 (1959)

Wadelin, C. W., Determination of Ozone and Other Oxidants in Air; Anal. Chem, 29:441 (Mar. 1957)

Wilburn, D., and Perrott, W., A Photometric Method of Measuring Ozone Surface Cracks in Rubber, PB Rept. 137, 532 24 pp. U. S. Govt. Research Reports, 31 341 (1959)

Winkelmann, H. A., Weatherseals in Automotive Applications; Paper Presented at the AME Passenger Car Body and Materials Metting, March, 1955

Winkelmann, H. A., Rubber's Tendency to Crack is Unpredictable; SAE Journal, :44 (Oct., 1955)

Yakubchik, A., Et al (State Univ. Leningrad) Comparitive Study of Cherical Structures of Synthetic Rubbers SKB and SKBM by the Method of Ozonolysis, Zhur. Obshchei Khim 28 3090 (1958)

Yakubchik, A., et al, Ozonization of Unsaturated Compounds III. Addition of Ozone to the Inner and the Outer Double Bonds in Butadiene Rubber, J. Gen Chem. U.S.S.R. 27 1561 (1957) (English translation)

Zuev, Yu. S., Malofeevskaya, V. F., Chemistry of Ozone Cracking of Rubber and the Action of Antioxidants; Trudy Nauch.-Issledovatel. Inst. Rezin. Prom., :27 (1960)

Zuev, Y., and Pravednikova, S., Effect of the Degree of Deformation on the Cracking of Rubbers in Ozone, Proc. Acad. Sci. U.S.S.R. Sect. Phys. Chem. 116 641 (1957)

Zuev, Yu. S., Pravednikova, S. I., The Influence of Ozone Concentration on the Cracking of Rubber; Trudy Nauch. - Issledovatel. Inst. Rezin. Prom., :3 (1960)

AGING BIBLIOGRAPHY

Achhammer, B. G., Reinhart, F. W., Kline, G. M., Mechanism of the Degradation of Polyamides, J. Research Nat. Bur. Standards, 46:391 (1951)

Albert, H. F., Effect of Certain Anti-oxidants in Gr-S. Natural and accelerated Aging, Ind. Eng. Chem., 40:1746 (1948)

Anderson, Herbert R. Jr., Rubber Cured and Reinforced with Sulfides: (improved physical properties after oven aging), U. S. 2,944,042 (July 5, 1960)

ASTM, Aging of Rubber, Symposium on; ASTM Spec. Tech. No. 89

Baldwin, Francis P., Hakala, Thomas H., Stabilization of Halogenated Butyl Rubber; U. S. 2,962,473 (Nov. 29, 1960)

Bartenev, G. M., Gorbatkina, Yu. A., Some Correlations in the Second-Order Transition of Rubbers; Vysokomolekulyarnye Soedineniya, 1:769 (1959)

Bergstrom, E. W., Aging of Unstressed Elastomeric Vulcanizates During Outdoor and Controlled Humidity Exposures; Rock Island Arsenal Lab. Tech. Report 58-1808

B. F. Goodrich Co., Nonstaining Rubber Antioxidant; (effect on NR compounds during accelerated aging are described), Brit. 820,170 (Sept. 16, 1959)

B. F. Goodrich Co., Nonstaining and Nondiscoloring Deterioration Retarders; Brit. 825,630 (Dec. 16, 1959)

Biggs, B. S., Deterioration of Organic Polymers; Bell System Tech. J., 30:1078 (1951)

Bluestein, A.C., Grossman, R. F., Effects of Brominated Butyl in Butyl Compounds; Rubber World, 142:98 (1960)

British Rubber Producers Research Assoc., Preservation of Hevea Latex; Brit. 821,872 (Oct. 14, 1959)

Buist, J. M., Aging and Weathering of Rubber; Rubber Chem. and Technol. 38:230 (1955)

Buist, J. M., Welding G. N., Use and Misuse of Accelerated Aging Tests; Trans. Inst. Rubber Ind., 21:49 (1945)

Burke, Oliver W. Jr., Antiozonants for Rubber and Other Unsaturated High Polymers; Brit. 841,281 (July 13, 1960

Chemische Werke Huls Akt.-Ges., Stabilization of Hydrocarbon Polymers; Brit. 826,262 (Dec. 31, 1959)

Dogadkin, B. A., (Inst. Fine Chem. Technol. Moscow), The Effect of Electric Charges, Occurring in the Process of Multiple Deformations, on the Fatigue Resistance of Vulcanizates, Kolloid Zhur, 20, 397, (1958)

Dunkel, W. L., Phelan, R. R., Accelerated Ozone Aging; Rubber Age, 83:281 (1958)

Dunlop Rubber Co. ltd., Elastomers with Improved Stability from Polycondensates and Isocyanates; Ger. 1,040,779 (Oct. 9, 1958)

Dunn, J. R., Oxidative Aging in Ultraviolet Light of Dicumyl Peroxide Vulcanizates of Natural Rubber in the Presence of Various Antioxidants; J. Appl. Polymer Sci., 4:151 (1960)

Dunn, J. R., Fogg, S. G., Protection of Transparent Vulcanizates Against Aging in Sunlight; J. Appl. Polymer Sci., 2:367 (1959(

Dunn, J. R., Scanlan, J., Changes in the Stress-Strain Properties of Natural Rubber Vulcanizates During Aging; Trans. Faraday Soc., 57:160 (1961)

E. I. du pont de Nemours Co., Elastomers Resistant to Oxygen, Ozone, and Other Oxidants, Ger. 1,052,676 (Mar. 12, 1959)

Eitingon, I. I., Tarasova, Z. N., et al, Antiaging Agent for Rubber; U.S.S.R. 128,604 (May 15, 1960)

Esso Research and Engineering Co., Stabilization of Butyl-Rubber Latex; Brit. 831,833 (Apr. 6, 1960)

Esso Research and Engineering Co., Stabilized Halogenated Butyl Rubber; Brit. 850,429 (Oct. 5, 1960)

Farbenfabriken Bayer AKT.-Ges., Hydroxybenzyl Ethers and their Use as Age-Resisters; Brit. 822,693 (Mar. 11, 1958)

Farbenfabriken Bayer Akt.-Ges., Hydroxybenzyl Ethers and their Use as Age-Resisters; Ger. 1,071,092 (Dec. 17, 1959)

Farbenfabriken Bayer AKt.-Ges., High-Molecular-Weight Polyurethan Foam Rubbers; Brit. 840,097 (July 6, 1960)

Fauvarque, Patrick, The Action of Iron on Heat Aging of Vulcanized Rubber; Rev. gen. Caoutchouc, 36:525 (1959)

Fiedler, Hans W., Deterioration - Retarding Agents for Vulcanized Rubber; Ger. 1,057,778 (May 21, 1959)

Ford, E. W., Cooper, L. V., A Study of the Factors Affecting the Weathering of Rubber-Like Materials; India Rubber World, (Sept. Oct. 1951)

Fusco, James F., Stabilization of Halogenated Butyl Rubber; U. S. 2,962,474 (Nov. 29, 1960)

General Tire and Rubber Co., Weather and Age-Resistant Polyurethane; Brit. 846,176 (Aug. 24,1960)

Giger, G., Le Bras, J., Alterungsschutz des Kautschuks durch Desaktivator-Wirkung; Kautschuk U. Gummi, 8:203 (1955)

Gillette, H. G., Shelf Aging of Elastomers; Precision Rubber Products Corp. No Official Publication

Goodyear Tire and Rubber Co., Preservation of Natural Rubber Latex; Brit. 836,250 (June1, 1960)

Greathouse, G. A., Effect of Microorganisms on Rubber Degradation; Rubber Age, 63:337 (June, 1948)

Hakala, Thomas H., Laffey, John J., Stabilizing Chlorinated Butyl Rubber; U. S. 2,964,463 (Dec. 13,1960)

Hall, G. L., Conant, F. S., Liska, J. W., Long-Term Aging of Elastomers Under Continuous Shear Load, India Rubber World (Feb. 1954)

Harris, James O., Improving the Resistance of Rubber to Degradation; U. S. 2,921,922 (Jan. 19, 1960)

Hobbs, L. M., Craig, R. G., Burklart, C. W., Vulcanization Without Free Sulfur of Butadiene - Styrene Rubber Resistant to Aging; Rubber World, 136:675 (1957)

Hunter, B., et al (U. S. Rubber Co., Naugatuck, Conn.) Styrene-Butadiene Rubber (SBR) - Important Stability Factors, Trans. Inst. Rubber Ind. 35 121 (1959)

Jahn, A. P., Vacca, G. N., Accelerated Aging Tests and Service Performance of Neoprene Jacketed Drop Wire; Wire and Wire Products 33:1178 (1959)

Juve, R. D., Johnson, F. M., Storage Stability of Tread Rubber and Tire-Repair Materials; Rubber World, 141:820 (1960)

Karmitz, Pierre, Rubber Protection Against Atmospheric Agents. I Examination of a Few Nickel Organic Compounds; Rev. gen. Caoutchouc, 35:1243 (1958)

Kemmnitz, G. (Glanzstoff-Court., G. M. 6. H., Kohn-Weidenpesch. Ger.) Investigation of Compression Fatigue and Damping Phenomena for Tire Cords, Kautschuk u. Gummi 12 WT 270-WT (1959)

Kimishima, Takuzo, Antiaging Agent for Rubber; Japan 15, 968 (Oct. 19, 1960)

Kochelev, F., and Kornev, A. (Lensovet Technol. Inst. Leningrad) Corrosion Resistance of Rubbers at High Temperature in Relation to Vulcanizing and the Nature of the Reinforcing Agent: Kauchuk i Rezina 17 No. 3. 16-19 (1958)

Le Bras, J., Neuartige Betrachtungen Über Alterungsprobleme von Kautschuk; Kautschuk u Gummi, 11:332 (1958)

Maizel, M., et al: Failure of Rubberized Fabric During Wear, Kauchuk i Rezina 18 No. 8. 28 (1959)

Mandel, J., Roth, F. L., Steel, M. N., Stiehler, R. D., Measurement of the Aging of Rubber Vulcanizates; J. Research Natl. Bur. Standards, 63C:141 (1959)

Manufactures de produits Chimiques du Nord, etablissements Kuhlmann; Protection of Elastomers Against Atmospheric Agents; Brit. 830,914 (Mar. 23, 1960)

Matheson, L. A. Bayer, R. F., Light Stability of Polystyrene and Polyvinylidene Chloride; Ind. Eng. Chem., 44:867 (1952)

Matsuda, Sumio, Antioxidant; (age resister for rubber) Japan 2313 (April 11, 1959)

Mercurio, A., and Tobolsky, A. (Princeton Univ., Princeton, N. J.) Stress Relaxation Studies of Scission in Rubber Vulcanizates, J. Polymer Sci. 36 467 (1959)

Meyer, G. E., Naples, F. J., Rice, H. M., Heat, Ozone, and Gamma-Radiation Stability of Highly Saturated Adduct Rubber Vulcanizates; Rubber World, 140:435 (1959)

Mitchell, C. E., Investigation of Cure Dated Items; Interim Report No. 2 submitted to Tinker Air Force Base, Oklahoma, May, 1959)

Monsanto Chemical Co., Vulcanizing Control and Aging Prevention of Rubber; Ger. 1,031958 (June 12, 1958)

Morris, Roger E., Alkylated Indanols Used as Deterioration Retarders for Rubber; U. S. 2,948,704 (Aug. 9, 1960)

Morris, Roger E., Alkylidenebisindanols as Deterioration Retarders for Rubbers; U. S. 2,969,343 (Jan. 24, 1961)

Morris, Hollister, J. W., Barrett, A. E. Wekenthin, T. A., Natural and Accelerated Light Aging of Hevea and GR-S Vulcanizates, Rubber Age, Apr., 1944

Morris, James, R. R., Wakenthin, T. A., Sunlight and Accelerated Light Aging of Synthetic Rubbers; Rubber Age, June, 1942

Neal, A. M., The Significance of Accelerated Aging Tests for Rubber; Du Pont Report No. 39-4 June, 1939

Nette, I. T., Pomortseva, N. V., Kozlova, E. I., Microbiological Degradation of Rubber; Mikrobiologiya, 28:881 (1959)

Nitrile Rubber; Trudy Nauch. Issledovatel Inst. Rezin. Prom., :25 (1960)

Oberto, S., Aging Fluorescence of Vulcanised Rubber; Rubber Tech. Conf., London Reprint No., 75 (May, 1938)

Ossefort, Z. T., Influence of Accelerator Residues on Age Resistance of Elastomeric Vulcanizates; Rubber World, 140:69 (1959)

Ossefort, Z. T., Shaw, R. F., Bergstrom, E. W. Vulcanizing Systems for Rubber Vulcanizates with Improved Resistance to Aging. I and II; Rubber world, 135:867 (1956), 136:65 (1957)

Ossefort, F. T., Shaw, R. F., Bergstrom, E. W., Curing Systems for Improved Aging Resistance of Rubber Vulcanizates; Rubber World (Mar. April, 1957)

Palmer, H. G., Crossley, R. H., Natural Aging of Reclaimed Rubber; Ind. Eng. Chem., 34:1367 (1942)

Patrikeev, G. A., Correlation Between the Mechanical Properties of Stretched Rubbers and their Structure; Zhur. Fiz. Khim., 33:2081 (1959)

Patrujova, A., Zanova, V., The Role of the Composition of Rubber Stocks in the Biological Breakdown of Cured Rubber Articles; Kauchuk i Rezina, 19:16 (1960)

Philpott, M., New Methods of Preserving Rubber Latex, Australian Plastics and Rubber J. 14 (159) 14-16 (1958)

Phoenix Gummiwerkd AKt.-Ges., Rubber of Improved Aging Resistance; Ger. 1,023,580 (Jan. 30, 1958)

Phoenix Gummiwerke AKt.-Ges., Additives for Protecting Rubber and Synthetic Resins Against Aging; Ger. 1,054,700 (Apr. 9, 1959)

Plantations des terres rouges, Preservation of Latex; Fr. 1,177,179 (Apr. 21, 1959)

Prober, Maurice, Amide - Stabilized Elastomeric Organopolysiloxanes, U. S. 2,945,838 (July 19, 1960)

Reinhart, F. W., Degradation of Plastics; Nat. Bur. Standards U. S. Circ.

Reznikovskii, M., et al (Sci. Research Inst. Tire Ind. Moscow) Effect of the Composition of a Rubber on its Fatigue Properties, Kolloid Zhur. 20 368 (1958)

Reznikovskii, M., et al (Leningrad, Gosudarst, Nauch-Tekh, Izdatel Khim, Lit.) Methods in the Study of Durability of Vulcanized Rubber Under Stresses Varying with Time. Starenie Utomlenie Kauchukov i Rezin i Povyshenie ikh stoikosti Sbornik 1955 76-88 Referat. Zhur. Khim 1957 Abstr. No. 6038.

Reznikovskii, M., Prizs, L., and Khromov, M., The Connection Between Fatigue Resistance, Strength Hysteresis and Chemical Stability of Rubbers, Kolloid Zhur 21 458 (1959)

Sakhnovskii, N., and Smirnova, L., Wear of Elastomers and Means of Improving It, Khim. Nauka i Prom 2 35 (1959)

Scanlan, J., and Watson, W. (British Rubber Producers Res. Assoc., Welwyn Garden City, Engl.) Interpretation of Stress-Relaxation Measurements Made on Rubber During Aging, Trans. Faraday Soc. 54 740 (1958)

Sekhar, B. C., Degradation and Cross-Linking of Polyisoprene in Hevea Brasiliensis Latex During Processing and Storage; Mezhdunarod Simposium po Makromol. Khim., Doklady, Moscow, Sektsiya 3:252 (1960)

Shaw, R. F., Adams, S. R., Nondestructive Aging Tests for Rubber; Anal. Chem., 23:1649 (1951)

Shelton, J. R., Oxygen-Absorption Methods. Their Utility and Limitations in the Study of Aging; ASTM Special Technical Publication No. 89 (1949)

Slonimskii, G., et al (Leningrad: Gosudarst. Nauch. Tekh. Izdatel, Khim. Lit.) The Mechanism of Rubber Fatigue, Starenie i Utomlenie Kauch. i Rezin i Povyshenie ikh Stoikosti Sbornik 1955 100-18 Referat Zhur. Khim. 1956 Abstr. No. 48830

Stevens, H. P., Photovulcanisation - A Study of the Products of the Action of Light on Rubber Under Conditions Precluding or Restricting Oxidative Degradation; India Rubber J., Jan., 1945

Socfin Co. ltd., Preservation of Natural Rubber Latex; Brit. 856, 055 (Dec. 14, 1960)

Thelin, J. H., Davis, A. R., Antioxidant - Antiozonant Activities; Rubber Age, 86:81 (1959)

Throdahl, M. C., Aging of Elastomers, Comparison of Creep With Some Conventional Aging Methods; Ind. Eng. Chem., 40:2180 (1948)

Thai, A., and Kello, V. (Tech. Hochschule, Bratislava, Czech.) Correlations Between the Degree of Cross-Linking and the Degradation of Natural Rubber, J. Polymer Sci. 31 291 (1958)

United States Rubber Co., Polyurethan Foams; Ger. 1,040,780 (Oct. 9, 1958)

Wald, Wilbur J., Age Resistors for Light-Colored Rubber Products; U. S. 2,952,662 (Sept. 13, 1960)

Webb, Frederick J., Nondiscoloring Age Resistors; U. S. 2,905,737 (Sept. 22, 1959)

Werkenthin, R. Z., Richardson, D., Thornleg, R. R., Morris, R. E., Light and Accelerated Light Aging of Rubber, Synthetic Rubber; and Rubber Substitutes; Rubber Age, Nov., 1941

Werkenthin, T. A., Richardson, D., Thornleg, R. R., Morris R. E., Equipment for Accelerated Light Aging of Rubber and Methods of Evaluation of Ultra Violet Light and Sunlight; India Rubber World Dec., 1941

Youmans, R. A., Maassen, G. C., Correlation of Room Temperature Shelf Aging with Accelerated Aging; Ind. Eng. Chem., 47:1487 (1955)

Zuev, Yu. S., The Light-Protective Action of Some Salts of Dialkyldithio carbamic Acids in Rubbers; Trudy Nauch. - Issledovatel Inst. Resin. Prom., :16 (1960)

Anonymous, The Chemical Problem of Rubber Degradation, No Official Publication

Anonymous, Ordinance Corps Program to Prevent The Deterioration of Elastomers; Lab. Rept. 53-3307 Aug., 1953

MISCELLANEOUS BIBLIOGRAPHY

American Hard Rubber, ACE Hard Rubber and Plastics Handbook, (1953)

Beach, K. C., Comper, L. F., Lowery, V. E., Laboratory Processing Properties of Two Synthetic Polymers; Rubber Age, 85:253 (1959)

Bauman, R. G., (B. F. Goodrich Center, Brecksville, Ohio), Radiation Damage to Elastomers; J. Appl. Polymer Sci., 1:328 (1959)

Bauman, Richard G., and Born, J. W., (B. F. Goodrich Research Center, Brecksville, Ohio), Mechanism of Radiation Damage to Elastomers I. Chain Scission and Anti-Radiation Acginm; J. Appl. Polymer Science, 1:139 (1959)

Barrer, R. M., Diffusion et Solution Dans Quelques Polymeres; J. Chem. Phys., 139 (1958)

Bartenev, G. M., and Zaitseva, V. D., Mechanical Vitrification and the Activation Enery of Rubber-Like Polymers, Vysokomolekulyarnye Soedinenier, 1:1309 (1959)

Biondi, M. A., Fox, R. E., Dissociative Attachment of Electrons in Iodine, III. Discussion; Phys. Rev., 109:2012 (1958)

Boguslavsky, D. B., et al, The Use of Nuclear Radiations for the Estimation of Homogeneity of Rubber Compsotions; Kauchuk, i Resina, 17,12,24 (1957)

Born, J. W., et al, (B. F. Goodrich Co., Research Center, Brecksville, Ohio) Combined Heat and Radiation Effects on Practical Rubber Compounds; Rubber World, 139:379 (392) (1958)

Buist, J. M., Lindsey, C. H., Naunton, W. J. S., Stafford, R. L., Williams, G. E., Study of Bonded Units; Ind. Eng. Chem., 43:373 (1951)

Buist, J. M., Meyrick, T. J., Stafford, R. L., Evaluation of Rubber to Metal Bonds; Trans. Inst. Rubber Eng., (1956)

Carlton, C. A., Gel Formation in Styrene-Butadiene Rubbers; Rubber World, 141:678 (1960)

Charlesby, A., Rukada, E., Dynamic Viscoelasticity of Polyester Cured by Irradiation; Rheol. Elastomers Proc. Conf., Welwyn Garden City, Engl., 1957 150-63, (Pub. 1958)

Chloride Electrical Storage Co., Ltd., Microporous Foils of Rubber of Synthetic Resins; Ger. 1,013,421 (Aug. 8, 1957)

Oluff, E. F., Gladding, E. K., Pariser, R., A New Method for Measuring the Degree of Crosslinking in Elastomers; J. Polymer Sci., 45:341 (1960)

Conant, F. S., Liska, J. W., Friction Studies on Rubber-like Materials; Rubber Chem. and Technol., 33:1218 (1960)

Crabtree, J., Bell. Lab. Record, J., Rubber and the Weather; 26:119 (1948)

Danjard, J. C., (Inst. Francais du Caoutchouc, Paris, France), Nuclear Magnetic Resonance Spectometry as Applied to the Study of High Polymers, Rev. Gen. Caoutchouc, 35:51 (1958)

Desanges, H., (Inst. Francais Caoutchouc, Paris, France), Changes in the Electrical Properties of Natural Rubber-Carbon Black Compounds During Pressure Vulcanization; Rev. Gen. Caoutchouc, 34:893 (1957)

Devirts, E. Ma., Koplan, M. G., Mudelman, E. N., Chemical Softening of Natural and Butadiene-Styrene Rubbers; Trudy Nouch-Issledovatel. Inst. Rezin. Prom., 3 (1960)

Dogadkin, B. A., Mladenov, I., Iutorskii, I. A., Transformation of Carboxylated Butadiene-Styrene Rubbers Under Influence of X-Radiation; Vysokomolekulyarnye Soedineniya, 2:259 (1960)

Drozdovskii, V. F., Shokhin, I. A., Regneration of Butyl Rubber Vulcanizates; U.S.S.R.128,140 (Apr. 28, 1960)

Dubrovin, G. I., et al, Action of Ionizing Radiation on Cable Rubber, Kauchuk i Rezina, 18, No. 7,8 (1959)

Esso Research and Engineering Co., Butyl Rubber Emulsions; Brit. 818,109 (Aug. 12, 1959)

Esso Research and Engineering Co., Improving the Adhesion of Chlorinated Butyl Rubber Tire Liners; Brit. 834,365; (May 4, 1960)

Esso Research and Engineering Co., Irradiation of Polymers and Copolymers of Isobutylene; Brit. 818,919 (Aug. 26, 1959)

Esso Research and Engineering Co., Stripping Solvent from Isobutylene-Isoprene Copolymer Latexes; Brit. 841,289 (July 13, 1960)

Feuerberg, H., Identification and Quantitative Determination of Elastomers in Vulcanizates; Kautschuk u. Gummi, 14:WT33 (1961)

Finigan, Charles M., Spehar, John P., Antifoam Agents for Butadiene Desorption; U.S. 2,884,474 (Apr. 28, 1959)

Fox, R. E., Dissociative Attachment of Electrons in Iodine. II. Mass Spectrographic Determination of the Energy Dependence of the Cross Section; Phys. Rev., 109:2008 (1958)

Fox, R. E., Hickam, W. M., Study of Carbon Monoxide, Nitrogen, Propylene, and Benzene Ionization Probability Curves Near Threshold; J. Chem. Phys., 22:2059 (1954)

Fox, R. E., Hickam, W. M., Kjeldaas, T., Jr., Ionization Probability Curves for Krypton and Xenon Near Threshold, Phys. Rev. 89:555 (1953)

Frank, H. P., Mark, H. F., Report on Molecular-Weight Measurements of Standard Polystyrene Samples. II. International Union of Pure and Applied Chemistry; 17:1 (1955)

Fujikura, Electric Wire Co., Adhering of Aluminium to Natural Rubber; Japan, 2037 (April 9, 1959)

Gale, R. S., (Rubber Research Inst., Malaya, Kuala Lumpur) Survey of Factors Involved in an Experimental Study of the Drying of Sheet Rubber; J. Rubber Research Inst. Malaya, 16, pt. 1, 38 (1959)

General Electric Co., Removal of Condensing Agents from Organopolysiloxane Elastomers; Ger. 1,017,793 (Oct. 17, 1957)

Gough, E., (Dunlop Rubber Co., Birmingham, Engl.), Friction of Rubber; Kautschuk u Gummi, 11, WT 303, WT 312 (1958)

Gul, V.E., Kovriga, V. V., Kamenskii, A. N., The Spontaneous Shrinking and Development of Structure of Polymers During Rupture; Doklady Akad. Nauk, S.S.S.R., 133:1364 (1960)

Hall, G. L, Rigby, J. B., Conant, F. S., High Speed Photography in the Rubber Industry; Rubber Age, (May, 1958)

Hayden, P., (At. Energy Res. Establ. Wantage, England), Estimation of Chain Fracture and Cross-linking of Rubber by High-Energy Radiation, Nature 184, no. 24 1865 (1959)

Hickam, W. M., Ionization Probability Curves Near Threshold for Zn, Cd, and Hg; Phys. Rev., 95:703 (1954)

Hickam, W. M., Fox, R. E., The Use of Ionization Probability Curves for the Analysis of CO and N_2 Mixtures, Westinghouse Research Laboratories, Scientific Paper 1650, (1952)

Hickam, W., Fox., R. O., Kueldana, T., Jr., Probability Curves Near Threshold for the Formation of He, Ne, A, Kr, and Xe by Electron Impact; Phys. Rev., 96:63 (1954)

Hirohy, R., and Wakelin, C., (Goodyear Tire and Rubber Co., Akron, Ohio) Determination of Free Sulphur in Vulcanization Accelerators, Rubber Chem. Technol., 32:123 (1959)

Hisada, Taro, et al, (Govt. Ind. Research Inst., Nagoya) Abrasion Measurement of Rubber with P32; Nagoya Kogyo Gijutsu Shikensho Hohoku, 5:241 (1956)

Hlousek, M., (Vysk. Ustav Makromol. Chemie, Brno., Czech.) Estimation of Size and Number of Particles in Synthetic Latexes, Chem. Prumysl, 9:265 (1959)

Hoffenberth, W., Tire Dynamics, Deutschuk u Gummi, 12 WT 136-40 (1959)

Isihara, A., Hashitoume, N., Tatibane, M., Statistical Theory of Rubber-like Elasticates. IV., J. Chem. Phys., 19:1508 (1951)

Johnson., P., and Kelsey, R., (Firestone Tire and Rubber co., Akron, Ohio) The Influence of Particle Size on the Viscosity of Synthetic Latex: Effect of Polydoispersity, Rubber World, 131:877 (1958)

Kalushenina, K. F., Skuba, I. A., et al, Increasing Adhesion of Rubber Mixtures and of Adhesives Based on Synthetic Rubbers; Trudy Nauch.-Issledovatel. Inst. Rezin. Prom, 47, Referat. Zhur., Khim., Abst. No. 33450 (1959)

Kanaki (Univ Hokkaido) Study of the Transition Phenomena of Chain Polymers by the Photoelastic Method, J. Phyrs. Soc. Japan, 13:1324 (19)

Katz, D. L., Beu, K. E., Nature of Asphaltic Substances; Ind. Eng. Chem., 37:195 (1945)

Kelsey, R., and Johnson, P., (Firestone Tire and Rubber Co., Akron, Ohio) The Influence of Particle Size on the Viscosity of Synthetic Latex II. Effect of Particle Spacing; Rubber World, 139:227 (1958)

Kivenson, G., Some Considerations in the Design of Double-Beam Analyzers for Industrial Control; J. Opt. Soc. Am., 40:112 (1950)

Kivenson, G., Osmar, J. J., Jones, E. W., Design of an Ultra-violet Analyzer; Anal. Chem., 21:769 (1949)

Kivenson, G., Roth, A., Rider, M., Some New Techniques in the Construction of Spectrographic Absorption Cells; J. Opt. Soc. Am., 39:484 (1949)

Kohler, T. R., Parrish, W., Conversion of Quantum Counting Rate to Roentgens; Rev. Sci. Instr., 27:705 (1956)

Koshelev, F., and Kornev, A., (Lensovet Technol. Inst. Leningrad) Corrosion and Resistance of Rubbers at High Temperature in Relation to Vulcanizing and the Nature of the Reinforcing Agent; Kauchuk i Rezina 17, No. 3, 16 (1958)

Kotitzer Ledertuch-und WachstuchWerke Akt.-Ges., Aqueous, Rubberlike Polyisobutylene Dispersions; Ger. 971,363 (Jan. 15, 1959)

Krause, K., Effect of Radiation on Polysiloxenes, Kunststoffe, 48, 584 (1958)

Kusminskii, A., and Zhurvskaya, E., Stability of Elastomers to the Action of Ionizing Irradiation; Khim Nauka i Prom, 4:69 (1959)

Letner, H. R., Application of Optical Interference to the Study of Residual Surface Stresses; Proc. Soc. Stress Anal., 10:23 (1952)

Letner, H. R., Residual Grinding Stresses in Hardened Steel; Trans. Am. Soc. Mech. Eng., (Oct., 1955)

Luke, C. L., Determination of Sulfur in Iron and Steel; Bell Telephone Laboratores. No official publication.

Luke, C. L., Photometric Determination of Sulfur in Metals and Alloys; Anal. Chem., 21:1369 (1949)

Luke, C. L., Determination of Sulfur in Nickel by the Evolution Method; Anal. Chem., 29:1227 (1957)

Madan, R., (Firestone Tire and Rubber., Brentford, England) Absorptiometric Determination of Traces of Cooper in Rubber Chemicals and Products; Rubber Age, 84:451 (1958)

Maeda, Y., (Hitachi Central Lab., Tokyo) Effect of Vulcanisation and Loading on Propagation of Ultrasonic Waves in Natural Rubber; Kobunshi Kagaku, 13:38 (1958)

Maeda, Y., (Hitachi C,o, Tokyo) Ultrasonic Velocity and Attenuation in Silicone Rubbers; Kobunshi Kagaku, 14:620 (1957)

Maisel, M., et al, Failure of Rubberized Frabric During Wear, Kauchuk i Resina 18, 8:28 (1959)

Marton, L., Simpson, J. A., Suddeth, J. A., An Electron Interferometer; Rev. Sci. Instr., 25:1099 (1954)

Mason, P., Viscoelastic Behavior of Rubber in Extension; J. Appl. Polymer Sci., 1:63 (1959)

MrGrew, F. C., Sharkey, W. H., Sharkey, W. H., Sorption of Acid Lyes by Nylon Under Non-equilibrium Conditions; Textile Research J., 21:875 (1951)

McKinney, J. S., Edelman, S., Marvin, R. S., Apparatus for the Direct Determination of the Lynamic Bulk Modules; J. Appl. Phys., 27:425 (1956)

Melville, H. W., Valentine, L., The Spectrophotometric Analysis of Copolymers of Styrene and p-Methoxistyrene; Trans. Faraday Soc., 51:1474 (1955)

Mocker, F., Polarographic Determination of Accelerators, Anti-Oxidants of Other Organic Compounds Used in the Rubber Industry; Kautschuk u. Gummill, WT 281, 282, 286, 288, 290, 292 (1958)

Mocker, F., (Veith-Gummiwerke Akt. Ges., Hochst/Odenwald, Ger.) Polarographic Determination of Accelerators, Anti-oxidants and Other Compounds Used in the Rubber Industry II., Kautschuk u Gummi 12, WT 155, WT 159 (1959)

Mooney, M., (U. S. Rubber Co., Wayne, New Jersey), A Diffusion Theory of the Viscoelasticity of Rubbery Polymers in Finite Elastic Strain, J. Polymer Sci., 34:601 (1959)

Mori, Y., and Minoura, Y., (Osaka City Ind. Research Inst.) Determination of Length and Numbers of Grafted Branches of Polystyrene on Natural Rubbers; Kogyo Kagoku Zashi, 61:263 (1958)

Morris, R. E., James, R. R., Caggegi, F., Effects of X Radiation on Compression Set of Rubbers; Rubber Age, 85:243 (1959)

Mueller, W. (Battelle Mem. Inst., Columbus, Ohio) Permeability of Rubber to Organic Liquids, Rubber Age, 81:982 (1957)

Muller, F., and Huff, K., (Univ. Marburg/Lahn, Marburg/Lahn, Germany) Alteration of the Dielectric Relaxation Spectrum of Rubber by Stretching; Kautschuk u. Gummi 11, WT 278-281 (1958)

Natural Rubber Producers Research Association, Inhibition of Volatile Fatty Acid XXXXXX formation in Hevea Latex; Brit. 861,940 (Mar. 1, 1961)

Nikitin, V. N., Volkova, L. A., et al, Two Crystalline Modifications of 1, 4-Trans-polybutadiene; Vysokomolekulyarnye Soedineniya, 1:1094 (1959)

Nikolinski, P., Slavov, Sh. H., Determination of Free Sulfur in Rubber; Godishnik Khim.-Technol. Inst., 3:85 (1956)

Nubert, D., and Saunders, D., (Brit, Rayon Research Assoc., Manchester, England) Some Observations of the Permanent Set of Cross-linked Natural Rubber Samples After Heating in a State of Pure Shear., Rheol. Acta, 1 151 (1958)

Oksentevich, L. A., Zhuravskaya, E. V., Action of Atomic Radiation on Rubbers; Trudy- Nauch.-Issledovatel. Inst., Rezin. Prom., 102 (1960)

Peerman, D. E., Tolberg, W., Floyd, D. E., Reaction of Polyamide Resins and Epoxy Resins; Ind., Eng. Chem., 49:1091 (1957)

Phillips Petroleum Co., Foam Suppression on Stripping Monomers from Butadiene-Styrene Elastomer Latex; Brit. 831,082 (Mar. 23, 1960)

Rehner, J. Jr., Gray, P., Determination of Unsaturation in Butyl Rubber; Ind. Eng. Chem., 17:367 (1945)

Riley, M. W., A Guide to Synthetic Rubbers; Materials Design Eng., Manual no. 141, Sept., 1957

Sakai, T., Ishihara, A., On the Statistical Theory of Rubber-Like Elasticity; J. Phys. Soc., Japan, 3:171 (1948)

Salinov, M., Zhuravskaya, E., and Kusminskii, A., Structural Changes of Sodium Butadiene Rubber Under the Action of Ionizing Radiations; Vestnik Moskov. Univ., Ser. Mat. Mekh. Astron. Fiz. i Khim., 14, No. 3:177 (1959)

Sakai, T., Isihara, A., On the Statistical Theory of Rubber-Like Elasticity; J. Colloid Sci., 4:71 (1949)

Salomon, G., Formation, Structure and Reactivity of Silver Salt Complexes; Cationic Polymerization and Related Complexes; (Proc. Conf. Univ. Coll. North Staffordshire, England) 1952

Salomon, G., Morphological Aspects of Abrasion and Wear; Engineering (London 173:310 (1952)

Sattler, L., Zerban, F. W., Clark, G. L., Chu, D. C., Albon, N., Gross, D., DeWhalley, H. C., Preparation and Properties of Frutose and Glucose Anhydrides, Ind. Eng. Chem., 44:1127 (1952)

Savinkova, A., Conditions of Syneresis and their Influence on the Properties of Filled Latexes and Vulcanizates Thereof. Kauchuk i Rezina 18, 3:18 (1959)

Schulz, G. J., Fox, R. E., Excitation of Metastable levels in Helium Near Threshold; Phys. Rev., 106:1179 (1957)

Simpson, J. A., The Theory of the Three-Crystal Electron Interferometer; Rev. Sci. Instr., 25:1105 (1954)

Slonimskii, G., and Drugova, G., (Inst. Tire Ind., Moscow) Mechanochemical Phenomena in Polymers. III. The Bond Strength Between The Polymers in Multilayer Polymer Products; Zhur. Fiz. Khim., 33:792 (1959)

Smith, W. M., Eberly, K. C., Hanson, E. E., Binder, J. L., Cis-and Trans-Polyesters Formed by Condensation of Geometric Isomers of 2-Butene-1, 4-Diols and Ethene-1, 2-Decarbonxylic Acids; J. Am. Chem. Soc., 78:626 (1956)

Societe des usines chimiques Rhone-Poulenc, Regeneration of Organopolysiloxane Elastomers; France, 1,169639 (Dec. 31, 1958)

Stafford, R. L., Physics of Raw and Vulcanized Rubbers; Ann. Rept. Progr. Rubber Technol. 23:24 (1959)

Stilson, V. M., Automotive Application of Vacuum Metalising; Paper presented before the SAE National Passenger Car, Body and Materials meeting, Detroit, Michigan, March, 1957

Straka, Leora E., Rubber Developments. A Review of the Literature for 1957-1959; Mech. Eng., 82:71 (1960)

Studebaker, Merton L., Nabors, Lester G., Chemistry of Reinforcement. IV. Model System Based on Carbon Black, Squalene, TMTD, and Laurex; Rubber Age, 85:984 (1959)

Thirion, P., The Tack of Crude Rubber and the Difficulties of its Determination; Adhesion, 2:65 (1959)

Thirion, P. (Inst. Francais cautchouc, Paris) Crude Rubber Tackiness and Evaluation Difficulties; Rev. gen cauthchouc; 35:441, 781 (1958)

Tobolsky, A. (Princeton Univ., Princeton, N. J.) Trends in Rubber Research; Rubber World, 139:857, 868 (1959)

Toyo Rubber Industry Co., Ltd., Chemical-Resistant Rubber; Japan, 10:334 (Aug. 1, 1960)

Turner, D. (Brit. Rubber Producers' Research Assocn., Herts, England) Gamma-Irradiation of Rubber and Styrene. Graft Polymer Formation, J. Polymer Science, 35:17 (1959)

Valclavek, Vladimir, Regulation of Molecular Weight in Styrene-Butadiene Emulsion Copolymenizating; Chem. Prumysl, 10:327 (1960)

Veersen, C. J. van, The Hydrocholorination of Rubber in Latex; Proc. Inst. Rubber Ind., Paper presented at the Rubber Technology Conference, London, June 1948

Volinov, M., et al (M.I. Kalinin Polytech. Inst., Leningrad) Thermoelastic Phenomena in Rubbers Based on Natural Latex During Cyclic Deformation, Soviet Phys.-Tech. Phys., 2:2143 (1947)

Uretz, R. B., Improved Ultraviolet Microbeam Apparatus; Rev. Sci. Instr., 28:861 (1957)

Waxker-Chemie G.m.b.H., Adhering Silicone Rubber to Other Materials; Ger. 970,125 (Aug. 21, 1958)

Wall, F. T., Erpenbeck, J. J., New Method for the Statistical Computation of Polymer Dimensions; J. Chem. Phys., 30:634 (1959)

Wall, F. T., Miller, L. A., Wheeler, D. J., Atchinson, W. F., Statistical Computation of Mean Dimensions of Macromolecules; I. II. III. IV; J. Chem. Phys., 22:1036 (1954) 23:913 (1955) 23:2314 (1955) 26:1742 (1957)

Wall, F. T., Rubin, R. J., Isaacson, L. M., Improved Statistical Method for Computing Mean Dimensions of Polymer Molecules; J. Chem. Phys., 27:186 (1957)

Watson, J. H. L., Crystalline Alpha-Ray-Aceteylene Reaction Products, Radiation Research; 3:121 (1955)

Witt, E. (B. F. Goodrich Research Center, Brecksville, Ohio) The Effect of Polymer Composition on Radiation-Induced Cross-Linking, J. Polymer Sci., 41:507 (1959)

Yakubchik, A. I., Filatova, V. A., Chemical Structure of Butadiene Rubber Irradiated with X-Radiation; Zhur. Priklad. Khim., 33:1172 (1960)

Yamada, T., and Fujiwara, H. (Dainichi Elec. Wire and Cable Co.) Amagasaki City, Electrically Conductive Butyl Rubber. Lowering Resistivity by Heat and the Influence of Vulcanizing Agents, Nippon Gomu Kyokaishi, 30:757 (1957)